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The Engineer

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(With a Two-Page Supplement).

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Chinese Engineering Notes.

New Method of Improving Power Factor.

A Modern Overhead Runway System.

PUBLIC NOTICES

TO WATER PUMPING PLANT ENGINEERS.

The Board of Agriculture for Scotland invite TENDERS for the following PLANT proposed for scheme in Forfarshire :—

(a) The SUPPLY and ERECTION of a WIND-MILL PUMPING PLANT complete, capable of raising 12,000 gallons per day.
(b) DO. DO. DO., to raise 10,000 gallons per day.
(c) The SUPPLY and INTRODUCTION of an OIL or PETROL ENGINE PUMPING PLANT complete, to raise 12,000 gallons in a period of from 4 to 5 hours.
(d) DO. DO. DO., to raise 10,000 gallons do. do.

Specifications can be obtained on application to the Board's Chief Surveyor.

CHAS. WEATHERILL, Secretary.

Board of Agriculture for Scotland,
York Buildings, Edinburgh. 853

The High Commissioner for India is prepared to receive TENDERS for the SUPPLY of :—

1. BRAKE FITTINGS, AUTOMATIC VACUUM AND HAND RIGGING COMPLETE, FOR GOODS WAGONS.
2. UNDERFRAMES AND BODY IRONWORK FOR RAILWAY CARRIAGES.

Forms of Tender may be obtained from the Director-General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, and Tenders are to be delivered at that office not later than Two o'clock P.M. on Tuesday, the 19th December, 1922, for No. 1 and on Friday, the 29th December, 1922, for No. 2.

T. RYAN, Director-General.

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G. R.

BY DIRECTION OF THE DISPOSAL BOARD.

For Sale by Private Treaty.
CLOSING DATE, 10 a.m., 8th DECEMBER, 1922.

3 "DUPLEX" AMMONIA COMPRESSION REFRIGERATING MACHINES,

each of an eliminating capacity of 1,250,000 B.T.Us. per hour, when cooling brine from 9 to 17 deg. Cent. By Haslam and Co., Ltd., together with motors, starters, condensers, coolers, pumps, &c.

Reference No. F.1/9, B/3 to 6, 8 to 26.

Location, Broomhills, Gretna.

Further particulars, permit to view and Tender form will be supplied on application to—

THE CONTROLLER, D.B.I.E., Disposal Board,
East's Court Exhibition,
814 London, S.W. 5.

Aberdeen Corporation Water-Works.
EXTENSIONS, 1920.
CONTRACT NO. 8.—NEW AQUEDUCT.

The Town Council of Aberdeen are prepared to receive TENDERS from competent persons willing to enter into a contract for the MANUFACTURE and DELIVERY of about 1¼ MILES of 4ft. diameter PIPES and SPECIALS of the following alternative types, viz.:—

(a) CAST IRON.
(b) MILD STEEL (LAP WELDED).

The drawings may be inspected and specification, schedule of quantities, and forms of Tender obtained on and after 30th November, 1922, on application at the Water Engineer's Office, 411, Union-street, Aberdeen.

For each specification of each type a deposit of Five Pounds sterling will be required, which sum will, after a Tender has been accepted, be returned to the tenderer, provided that he shall have sent in a bona fide Tender, based on the drawings, specification and schedule of quantities provided, with the schedule of quantities fully priced out in detail and shall not have withdrawn the same.

Tenders, on the forms prescribed and enclosed in securely sealed envelopes, endorsed "Tender for Aqueduct Piping," are to be addressed to the undersigned. No Tender delivered after 5 p.m. on the 14th December, 1922, will be considered.

The Town Council do not bind themselves to accept the lowest or any Tender.

GEORGE MITCHELL, M. Inst. C.E., Water Engineer.

Water Engineer's Office,
411, Union-street, Aberdeen,
24th November, 1922. 847

Aberdeen Corporation Water-Works.
EXTENSIONS, 1920.
CONTRACT NO. 9.—NEW AQUEDUCT.

The Town Council of Aberdeen are prepared to receive TENDERS from competent persons willing to enter into a contract for the TRANSPORTING, LAYING and JOINTING of 1¼ MILES of 4ft. PIPING and ANCILLIARY WORKS between West Cults and Pitfodels.

The drawings may be inspected and specification, schedule of quantities, and forms of Tender obtained on and after 30th November, 1922, on application at the Water Engineer's Office, 411, Union-street, Aberdeen.

For each specification a deposit of Five Pounds sterling will be required, which sum will, after a Tender has been accepted, be returned to the tenderer, provided that he shall have sent in a bona fide Tender, based on the drawings, specification and schedule of quantities provided, with the schedule of quantities fully priced out in detail, and shall not have withdrawn the same.

Tenders, on the forms prescribed and enclosed in securely sealed envelopes, endorsed "Tender for Aqueduct Pipe Laying," are to be addressed to the undersigned. No Tender delivered after 5 p.m. on the 14th December, 1922, will be considered.

The Town Council do not bind themselves to accept the lowest or any Tender.

GEORGE MITCHELL, M. Inst. C.E., Water Engineer.

Water Engineer's Office,
411, Union-street, Aberdeen,
24th November, 1922. 848

Administrative County of LONDON.

The London County Council invites TENDERS for the CONSTRUCTION (in Reinforced Concrete) of OPEN-AIR SWIMMING BATHS at Highbury Fields and Southwark Park, and a SWIMMING POOL at Peckham Rye. The whole of the labour is to be obtained from the Employment Exchanges. Specification, plans, form of Tender and contract can be had on application to the Chief Officer, Parks Department, County Hall, Westminster Bridge, S.E. 1. Tenders must be delivered in the envelope provided to the Clerk of the Council at the County Hall not later than 4 P.M. on Monday, 18th December, 1922.

JAMES BIRD, Clerk of the London County Council.

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PUBLIC NOTICES

Bengal-Nagpur Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for :—

PNEUMATIC PLANT.

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after 28th November, 1922.

A fee of £1 1s. will be charged for the specification, which will not be returned.

Tenders must be submitted not later than Noon on Tuesday, 12th December, 1922.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
R. C. VOLKERS, Secretary.

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County Borough of Bolton.
WATERWORKS DEPARTMENT.
LOWER HEIGHTS BORE-HOLE.

TENDERS are INVITED for the SINKING of a BORE-HOLE, having a commencing diameter of not less than 30in. and a terminating diameter of not less than 18in. at a depth of 600ft., and for the Construction of other Works connected therewith at Belmont, near Bolton.

The drawings, conditions of contract, specification, schedule for prices, instructions to persons tendering and form of Tender, can be seen on application to Mr. John K. Swales, M. Inst. C.E., Waterworks Engineer, 88, George's-street, Bolton, and copies may be obtained on the deposit of Two Guineas, which will be returned to tenderers who have submitted a bona fide Tender and returned all the documents supplied.

Tenders are to be submitted in accordance with the "Instructions to Persons Tendering" above referred to before 10 a.m. on the 11th December, 1922.

SAMUEL PARKER, Town Clerk.

Town Hall,
Bolton.
17th November 1922. 788

Great Northern Railway Company (IRELAND).
TENDERS FOR SLEEPERS.

The Directors are prepared to receive TENDERS for the SUPPLY of SOFTWOOD SLEEPERS, 9ft. by 10in. by 5in.

Tenders, made out on forms supplied by the Company, should be delivered, under sealed cover, endorsed "Tender for Sleepers," not later than 10 a.m. on Thursday, 14th December, 1922.

The Directors do not bind themselves to accept the lowest or any Tender.

J. B. STEPHENS, Secretary.

Amiens Street Station, Dublin,
22nd November, 1922. 845

Great Northern Railway Company (IRELAND).
TENDERS FOR SWITCHES.

The Directors are prepared to receive TENDERS for the SUPPLY of SWITCHES in accordance with the Company's drawing and specification.

Copies of the drawing, specification and Tender form may be obtained from the undersigned.

Tenders, on the forms supplied by the Company, should be delivered, under sealed cover, endorsed "Tender for Switches," not later than 10 a.m. on Thursday, 21st December, 1922.

The Directors do not bind themselves to accept the lowest or any Tender.

J. B. STEPHENS, Secretary.

Amiens Street Station, Dublin,
29th November, 1922. 894

PUBLIC NOTICES

East Indian Railway.

The Directors are prepared to receive up to Eleven o'clock a.m. on Wednesday, the 13th December, TENDERS for the SUPPLY of :—

(1) AXLES for CARRIAGES and WAGONS.
(2) AXLE-BOXES for CARRIAGES and WAGONS.

Copies of the specifications can be obtained at the Company's offices on payment of £1 1s. each. This fee will not be returned.

G. E. LILLIE, Secretary.

73-76, King William-street, London, E.C. 4,
29th November, 1922. 880

South Staffordshire Waterworks COMPANY.
SANDFIELDS PUMPING STATION, LICHFIELD.
CONTRACT No. 1.

The Chairman and Directors invite TENDERS from engineering firms experienced in the Design, Construction and Erection of High-class Pumping Engines and Marine Engine Work for SUPPLYING and ERECTING DIESEL or STEAM ENGINES with ELECTRIC GENERATORS, FORCE PUMPS and WELL PUMPS, to be erected in the existing Engine-house at their Sandfields Pumping Station, Lichfield.

The plant to be capable of pumping 4,000,000 gallons per 24 hours continuously against a total head of 440ft., including friction.

Copies of general conditions, specification and plans may be obtained from the undersigned.

The lowest or any Tender will not necessarily be accepted.

FRED. J. DIXON, M.Inst.C.E., M.I.Mech.E. Engineer.

18th November, 1922.
26a, Paradise-street,
Birmingham. 792

South Staffordshire Waterworks COMPANY.
SANDFIELDS PUMPING STATION, LICHFIELD.
HANCH RESERVOIR AND TUNNEL WATER, CHEMICAL TREATMENT AND FILTRATION INSTALLATION.
CONTRACT No. 2.

The Chairman and Directors invite TENDERS from manufacturers experienced in the Design, Construction and Erection of Rapid Gravity or Pressure Filters for the purpose of TREATING and FILTERING WATER at the Sandfields Pumping Station.

The plant to be capable of dealing with a maximum supply of 4,000,000 gallons per 24 hours continuously.

Copies of general conditions, specification and plans may be obtained from the undersigned.

The lowest or any Tender will not necessarily be accepted.

FRED. J. DIXON, M.Inst.C.E., M.I.Mech.E., Engineer.

18th November, 1922.
26a, Paradise-street,
Birmingham. 793

County Borough of Salford.
ELECTRICITY DEPARTMENT.
RESIDENT CIVIL ENGINEER AND CLERK OF WORKS.

APPLICATIONS are INVITED for the POST of RESIDENT CIVIL ENGINEER and CLERK of WORKS to supervise under the direction of the Consulting Engineers the Building Construction Work of the Agecroft Power Station.

Applicants must have had suitable experience in Brickwork, Concrete and Steel Work Construction, &c., in connection with heavy civil engineering works.

None but thoroughly qualified applicants need apply.

Applications, endorsed "Resident Civil Engineer and Clerk of Works," stating age, experience, and salary required, with copies of three recent testimonials, to be delivered at the office of the undersigned not later than Thursday, 7th December, 1922.

Canvassing, either directly or indirectly, will disqualify.

831 L. C. EVANS, Town Clerk.

PUBLIC NOTICES

PATENTS AND DESIGNS ACTS, 1907 and 1919.

Notice is Hereby Given that FREDERICK GILBERT BRETTELL, of 77, Colmore-row, Birmingham, Chartered Patent Agent, and a British subject, SEEKS LEAVE to AMEND the SPECIFICATION of LETTERS PATENT No. 184,379, and entitled "CONTINUOUS WIRE-WORKING MACHINE."

Particulars of the proposed amendment were set forth in the Illustrated Official Journal (Patents) issued on the 22nd November, 1922.

Any person, or persons, may give notice of opposition to the Amendment by leaving Patents Form No. 19 at the Patent Office, 25, Southampton-buildings, London, W.C. 2, within one calendar month from the date of the said Journal.

W. TEMPLE FRANKS, Comptroller-General.

P6529

The South Indian Railway Company, Limited, are prepared to receive TENDERS for the SUPPLY of :—

1. METALS.
2. SPARE PARTS of CARRIAGES and WAGONS.
3. STEEL FISH-PLATES (Special Patterns).
4. COPPER RODS and INGOTS.
5. LEATHER HIDES, &c.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tenders for Metals," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 8th December, 1922.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 10s. for each copy of the specifications.

Copies of the drawings may be obtained at the offices of Messrs. Robert White and Partners, Consulting Engineers to the Company, 8, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD, Managing Director.

91, Petty France, S.W. 1,
27th November, 1922. 858

Stevenage Urban District COUNCIL.
SALE OF WATERWORKS PUMPS.

The above-named Council invite TENDERS for the PURCHASE of a SET of THREE-THROW DEEP WELL SINGLE-ACTING LIFT and FORCE PUMPS, together with 6in. CAST IRON RISING MAIN to surface, and TOP GEARING, by Messrs. Glenfield and Kennedy, Ltd., Kilmarnock, in good condition, fixed in a well 175ft. deep, at the Stevenage Waterworks, the purchaser to remove the same at his own expense.

Tenders, marked "Tender for Pumps," to be received by me not later than Saturday, the 16th December, 1922.

W. O. TIMES, Clerk to the Council.

Council Offices, Stevenage. 862

SITUATIONS OPEN

WANTED, a TRAINED ENGINEER with Up-to-date experience in Condensing Machinery, to Assist in Engineering Office of well-known Company making condensing plants a speciality. The candidate should be accustomed to the preparation of tenders as well as possessed of ability and expert knowledge to enable him to successfully negotiate contracts. He should be a thoroughly good business man with wide connections and competent to develop the condensing machinery business.—Address, with fullest particulars, age and salary required, 852, The Engineer Office. 852 A

WANTED by Firm of Hydraulic Engineers, a LEADING DESIGNER, familiar with the Designing of Plantation and Manufacturing Rubber Machinery, also with a good knowledge of Hydraulic Machinery. Give full particulars, &c.—Address, 883, The Engineer Office. 883 A

WANTED, Real Live Energetic TRAVELLER, to represent progressive engineering firm manufacturing Stonebreaking Machinery, Tar-macadam Plant, Concrete Mixing Machinery, Elevating, Screening and Conveying Plant, to call on Surveyors, Builders, Contractors and Quarry Owners, &c. Low salary and commission basis. Draughtsmanship experience an advantage. State age and experience in full, also remuneration proposed.—Address, 883, The Engineer Office. 885 A

ENGINEER REQUIRED by English Company, to Take Charge Construction about 50 Miles Railway, Portuguese East Africa. Salary £750 per annum and house.—Write, giving full particulars with references (copies), to Box "D, C. C.," c/o Davies and Co., 95, Bishopsgate, E.C. 2. 872 A

STEEL (Electric) FOUNDRY MANAGER. Product, highest class. Thorough commercial and metallurgical experience. Only first-rate men considered. Applications in confidence, stating age, experience, present position, salary required, when free.—Address, 846, The Engineer Office. 846 A

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SITUATIONS OPEN (continued)

WORKS MANAGER REQ. by London Motor Cycle and Engine Co. Investment £1000. Only those with necessary capital reply. Salary £416, dividend, 1 per cent. com. on works output. Freehold works, busy. Trade £70,000. Audited a/cs. Accountants' refs.—Apply, Messrs. TITCHFIELD, 23, Gt. Titchfield-street, Oxford-circus, London. 887 A

WANTED, SEVERAL FIRST-CLASS DRAUGHTSMEN as Leading Hands on Switchgear Work. Age, salary, experience and when disengaged.—Address, 835, The Engineer Office. 835 A

WANTED, Good SENIOR DRAUGHTSMAN with Lay-out Experience on Electrical Side of Central Stations. Age, salary, and when disengaged.—Address, 854, The Engineer Office. 854 A

WANTED, TWO Experienced LADY TRACERS for large Engineering Works in Bedford. State age, experience, and salary.—Address, 861, The Engineer Office. 861 A

A JUNIOR ENGINEERING ASSISTANT is REQUIRED in the Drawing-office of an important Municipal Undertaking in the Midlands.

The successful applicant must be a good draughtsman and have had a suitable training in Waterworks Engineering and Surveying. Preference will be given to Associate Members or Students of the Institution of Civil Engineers.

Applications stating age, experience, qualifications, and salary required, together with copies of three recent testimonials, to be sent to 858, The Engineer Office. 858 A

DRAUGHTSMAN (Experienced) REQUIRED; knowledge Cooling, Heating, and Condensing Apparatus. State qualifications and salary.—Address, 891, The Engineer Office. 891 A

DRAUGHTSMAN REQUIRED for the Design Office of an established Firm of Lift Engineers. Experience in Mechanical and Electrical Design essential.—Address, stating age, experience, and salary required, 885, The Engineer Office. 885 A

DRAUGHTSMAN.—WANTED, for Manchester District, SENIOR LOCOMOTIVE DRAUGHTSMAN, capable of working out structural and running gear of electric locomotives. Knowledge of electricity not essential. Applications to include age, experience, and salary required.—Address, 860, The Engineer Office. 860 A

DRAUGHTSMAN WANTED, Thoroughly Conversant with the design of all classes of Centrifugal pumps, High and Low Lift.—Reply, stating age, experience, and salary required, Box No. 88, Brown's Advertising Office, 166, Buchanan-street, Glasgow. 802 A

DRAUGHTSMAN.—WANTED, on the N.E. Coast, AT ONCE, STRUCTURAL DRAUGHTSMAN, experienced in Checking Contractors' Design and Works Department Drawings for Heavy Steel Buildings. Shop and erection experience would be useful, but is not essential. Applicants should state age, wage required, and give an outline of experience, with names of past employers.—Address, 871, The Engineer Office. 871 A

DRAUGHTSMAN, with Good Knowledge Traction Motors, Electric Vehicles, &c., capable of planning and designing jig and tool lay-outs, 45 per 41 hours' week; London district.—Address, 869, The Engineer Office. 869 A

FIRST-CLASS ENGINEERING DRAUGHTSMAN for specialised industry (London office). Knowledge of Steam Generating Plant and Lay-out of General Engineering Work advantageous. Practical and theoretical training essential. Progressive position.—Particulars of experience, age, salary required to Box "E," c/o The Recent Advertising Service, Ltd., 4, London Wall-buildings, London, E.C. 2. P6513 A

WANTED, FOUNDRY FOREMAN, Experienced in Moulding Large Marine Castings and General Heavy Machine Tool Castings.—Apply, THE SHEEPBRIDGE COAL and IRON CO., Ltd., Chesterfield. 764 A

ENGINEER-ELECTRICIAN.—FITTER REQUIRED in Scotland, fully competent to install, overhaul and adjust Petrol, Paraffin and Hydro-electric Plants, Automatic Switchgear, &c. State fully experience and wages. Permanent if satisfactory. Only thoroughly experienced men will be considered.—Address, P6526, The Engineer Office. P6526 A

HEAD ORDER CLERK, with Thorough Knowledge of organisation of Order Dept. in Engineering Works.—Address, with fully details as to experience, character, &c., 876, The Engineer Office. 876 A

SITUATIONS WANTED

BUYER.—The MANAGER of a Large Engineering Works Purchasing Dept., who has an exceptionally wide knowledge of the markets of the country, DESIRES to NEGOTIATE NEW APPOINTMENT.—Write, Z. M. 613, c/o Deacon's, Leadenhall-street, E.C. 886 B

CAMBRIDGE GRADUATE (23), Honours Engineering Tripos, 1922, DESIRES PRACTICAL EXPERIENCE under agreement, with firm of Civil, Railway or Constructional Engineers, with a view to A.M.I.C.E.

Address, P6525, The Engineer Office. P6525 B

ENGINEER SALESMAN, Age 30, Possessing ability, sound common-sense, at present engaged in the sale of machine tools, well connected, merchants, &c., SEEKS ANY PROPOSITION; would consider opening London office.—Address, P6515, The Engineer Office. P6515 B

GENTLEMAN DESIRES SIT. as DRAUGHTSMAN. Experience: 10 years rolling vehicle, 5 years mech. detail and general engineering; age 30.—Address, P6537, The Engineer Office. P6537 B

HEAT TREATMENT.—GENTLEMAN, with Sound practical and commercial experience, all steels and metals, furnace construction and general engineering, SEEKS responsible POSITION.—Address, P6538, The Engineer Office. P6538 B

MANAGER of General Engineering Works, including boiler shop and foundries, with experience on repetition work, accustomed to control of office, staff and shops, DESIRES SIMILAR ENGAGEMENT at an early date; age 42.—Address, P6520, The Engineer Office. P6520 B

MECHANICAL ENGINEER, 8 Years Works, 6 Years D.O., general engineering, technical training, POST WANTED, any capacity; London district; first-class refs., keen, energetic.—Address, P6514, The Engineer Office. P6514 B

SALES ENGINEER SHORTLY DISENGAGED. Practical, theoretical and commercial experience in marine, mining, electrical and mechanical engineering; age 28 years.—Address, P6527, The Engineer Office. P6527 B

WORKS MANAGER, Steel Tube Works, REQUIRES similar APPOINTMENT or ASSISTANT to DIRECTOR. Conversant with modern methods, seamless and welded tubes; British and American practice.—Address, P6536, The Engineer Office. P6536 B

FOUNDRY FOREMAN, Desiring Change, SEEKS POSITION with progressive firm, home or abroad; would equip new foundry if required; confidential correspondence invited; good references.—Address, P6519, The Engineer Office. P6519 B

FOUNDRY FOREMAN (43) DESIRES POSITION. Practical experience in loam, dry and green sand; modern methods in plate and machine moulding, jolt rams and oil sand cores.—Address, P6523, The Engineer Office. P6523 B

SITUATIONS WANTED (continued)

MACHINE SHOP FOREMAN of Pre-war Experience, REQUIRES RE-ENGAGEMENT; experience of both general and mass production work; technical and practical qualifications; thoroughly capable of handling men and obtaining high efficiency. Age 34.—Address, P6531, The Engineer Office. P6531 B

STOKER REQUIRES SITUATION. Any Boiler, own repairs and cleaning; knowledge of steam machinery.—PIPER, Acacia Cottage, Clinch Green, Bexhill-on-Sea. P6521 B

PARTNERSHIPS

ENGINEERING PARTNERSHIPS AND BUSINESSES.

Wheatley Kirk, Price & Co.,

46, Watling Street, London, E.C. 4.

Established seventy years.

ENGINEER, Age 35 (Public School Man), with first-class practical and commercial experience at home and abroad, DESIRES PARTNERSHIP or DIRECTORSHIP in sound progressive engineering or merchant business. Capital available £3-4000.—Address, P6518, The Engineer Office. P6518 C

ENGINEER-MANAGER, Electrical and Mechanical manufacturing experience, technical, factory installation, power and lighting, drawing-office, &c., business acumen, REQUIRES salaried POSITION in sound established business. Available capital £3000. Principals only. No speculations or inventions. Full particulars in confidence.—Address, P6534, The Engineer Office. P6534 C

PARTNERSHIPS and ACTIVE DIRECTORSHIPS WANTED in Mechanical, Constructional, Electrical Engineers, &c., for Clients with technical experience and capital from £1000 to £20,000.—GILBERT and PRATT, 18, Walbrook, London, E.C. 4. Ex C

EDUCATIONAL

A BROCHURE on "ENGINEERING SALESMANSHIP and SALES MANAGEMENT," with particulars of a SPECIAL COURSE of TRAINING, will be sent post free on application to SECRETARY, THE INSTITUTE OF ENGINEERING SALESMANSHIP, 333, Oxford-road, Manchester. P6195

CORRESPONDENCE COURSES for Inst. C.E., Inst. Mech. E., London Univ. (Matric., Inter., and B.Sc.) personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours), Assoc. M. Inst. C.E., M.R.S.I., F.R.S.A., &c. Also Day Tuition in Office. Excellent results at all Exams. Courses may commence at any time.—8/11, Trafford Chambers, 58 South John-street, LIVERPOOL. Ex. B

INST. C.E., Inst. Mech. E., B.Sc., and all ENGINEERING EXAMINATIONS.—Mr. G. P. KNOWLES, M.B.E., B.Sc., A.M. Inst. C.E., &c., personally PREPARES CANDIDATES, either orally or by correspondence. Thousands of successes during the past sixteen years. Courses can be commenced at any time.—99, Victoria-street, Westminster S.W. Telephone No., Victoria 4780. Ex. B

LEARN SURVEYING AND LEVELLING.—Thorough practical instruction given by an expert.—Address, E. MOUL (late L.S.W. and S.P.D. Rlys.) Hollybank, Woking. P6221 B

AGENCIES

AGENCY (Buying or Selling) REQUIRED by established London firm, with an exceptional personal connection amongst engineers in London and South-Eastern Counties, Government Departments, Export Merchants, &c.—ALLSOP and MASE, 26-28, Holborn-viaduct, London, E.C. 1. P6522 D

AGENT WANTED in Birmingham District to represent well-known firm of Furnace Makers. State connections.—Address, 849, The Engineer Office. 849 D

ENGINEER, A.M.I. Mech. E., with an Office in London suburb, is OPEN to TAKE UP SOLE AGENCY of any good selling line in which mechanical engineering experience would be an advantage.—Address, P6517, The Engineer Office. P6517 D

ENGINEER, Good General Experience and Connection, with office, Central district, Glasgow, DESIRES good AGENCY.—Address, "EFFICIENCY," Wm. Porteous and Co., Advertising Agents, Glasgow. P6516 D

ESTABLISHED ENGINEER, A.M.I. Mech. E., Central offices, staff, Birmingham, DESIRES additional REPRESENTATION. Firm of repute; first-class repeat lines; live connection, 30 miles radius; every investigation; basis, commission or arrangement.—Address, P6485, The Engineer Office. P6485 D

EXPERIENCED ENGINEER, A.M.I.C.E., M.I.M.E., DESIRES to ACT as REPRESENTATIVE ENGINEER in London for good provincial, continental or other firm.—Address, P6136, The Engineer Office. P6136 D

LONDON ENGINEER, Centrally Located Offices, stores, drawing, 'phone, many years' sales experience English and American houses, highest references, DESIRES to REPRESENT substantial FIRM.—P. WRIGHT, Sentinel House, London, W.C. 1. P6528 D

MACHINERY, &c., WANTED

WANTED, ONE MOTOR GENERATOR, 15 to 20 K.W., motor side 500 volts, generator 230 volts. Complete with Motor Starter and Field Rheostat for Generator. Please state makers' name and date of machine; also where it can be seen.—Address, 893, The Engineer Office. 893 F

WANTED, Good Second-hand PLATE EDGE PLANING MACHINE, 16/17ft. stroke.—Send size, maker, and full particulars to REES and KIRBY, Ltd., Swansea. P6535 F

WANTED, Heavy Type ELECTRIC DRILL, 230 volts direct current; drill holes up to 1½in. diameter. Give particulars and price.—Address, 859, The Engineer Office. 859 F

HYDRAULIC BALING PRESS WANTED. About 150 tons at 1500 lb. pressure, with steam-heated platens approximately 2ft. or 3ft. square, first-class condition.—Address, 883, The Engineer Office. 883 F

TWIST DRILL FLUTING MACHINES and also UNIVERSAL GRINDERS, large size, new or good second-hand, WANTED IMMEDIATELY.—Address, 875, The Engineer Office. 875 F

FOR HIRE

FOR HIRE, PUMPS and WELL-BORING TOOLS for Contractors' Deep Wells, &c., 2in. to 24in. dia.—E. RICHARDS and CO., Upper Ground-street, London, S.E. Telephone No. 978 Hop. 823 K

FOR SALE or HIRE, ELECTRIC MOTORS, from 60 to 300 H.P.; PORTABLE STEAM ENGINES, from 8 to 40 N.H.P.; STEAM BOILERS, CRANES, PUMPS, MACHINE TOOLS of every description; reasonable terms, immediate delivery.—J. T. WILLIAMS and SONS, 37, Queen Victoria-street, London, E.C. Tel., City 5936. Ex. K

MISCELLANEOUS

ADVERTISERS are Contemplating the Putting Down of a Plant for the making of Small Steel Shells of 3-8in. to 1in. thickness of plates and in sizes from 7ft. long by 4ft. diameter down to 3ft. long by 1ft. 6in. diameter; plant to include Shears, Roller, Riveting (pneumatic or hydraulic), Flanging Machine to throw over the edges of the bodies instead of using angle iron; and the same machine to be suitable for the flanging of copper bodies.

Makers of such machines to reply in first instance to Box 736, Office of this paper, the publishers of which will guarantee genuineness of this advertisement. 736 I

IF YOU REQUIRE DIVIDING HEADS for MILLING, ROTARY TABLES for SLOTTING and MILLING, Write to THE WHEELER MNFG. CO. Ltd., 65F, Trench Crossing, Wellington, Salop.

PATENTS

INVENTIONS DEVELOPED, PATENTED, and SOLD for Clients by Engineers (late of Vickers Ltd., B.Sc., M.E. Ac. S., A.M.I. Ae. E.). Strictest confidence, most moderate terms.—FORTIS and PARTNERS, 60, Queen Victoria-street, E.C. 4. Tel., Cent. 3264. 513 H

THE PROPRIETOR of LETTERS PATENT No. 138,071, relating to—"METHODS of WELDING CHAIN LINKS," DESIRES to DISPOSE of his PATENT or to GRANT LICENCES to interested parties on reasonable terms with a view to the adequate working of the patent in this country.

Inquiries to be addressed to—CRUIKSHANK and FAIRWEATHER, 65-66, Chancery-lane, London, W.C. 2. 873 H

THE PROPRIETORS of LETTERS PATENT No. 136,540, relating to "STEAM TRAPS," DESIRE to DISPOSE of their PATENT or to GRANT LICENCES to interested parties on reasonable terms, with a view to the adequate working of the patent in this country.—Inquiries to be addressed to—CRUIKSHANK AND FAIRWEATHER, 65-66, Chancery-lane, London, W.C. 2. 784 H

FOR SALE

A LEADING LIST

OF NEW and SECOND-HAND MACHINERY can be obtained from W. H. PEASE and CO., Ltd. Hastings House, Norfolk-street, London.

TELEGRAMS: "ENGIPEASE, ESTRAND, LONDON."

SEE OUR ADVERT. ON PAGE 31 OF LAST ISSUE. Ex. C

CHEAP.—Built-up GIRDERS, 20in. by 8½in. by 26ft. long; H GIRDERS, 16in. by 6in. by 11ft. 6in., 14in. by 6in. by 8ft. 2in., 10in. by 5½in. by 20ft., 9in. by 4in. by 18ft.; ANGLES, 3in. by 3in. by 11in. by 13ft. 6in., 3½in. by 2½in. by 5ft. 3in. and 5ft. 9in.—Apply, THE WARD BOILER SETTING ENGINEERS, Ltd., 1, Victoria-buildings, Manchester. 762 G

DYNAMO, by Newtons, Type No. 28,506, 60 K.W., 460 volts, 250 revs., for direct drive, with flexible coupling. This is a new machine.

DITTO, for belt drive, 50 K.W., 780 revs.

DITTO, 40 K.W., 220/300 volts.

JOSEPH PUGSLEY and SONS, Ltd., Cattybrook Ironworks, Lawrence Hill, Bristol. 851 G

ENGINES FOR SALE.—

1 Patent Compound Horizontal Tandem Condensing Engine, by Pollit and Wigzell, Ltd., 1900; I.H.P., 700-900, pressure 180 lb.

1 Horizontal Compound Tandem Corliss High-pressure Engine (reconditioned by Pollit and Wigzell, Ltd., 1900); I.H.P. 650, pressure 150 lb.

LANCASHIRE BOILERS FOR SALE.—

2 30ft. by 9ft., by Spurr, Inman and Co., 1900, w.p. 150 lb.

1 30ft. by 9ft., by T. Besseley and Sons, Ltd., 1906, w.p. 150 lb.

2 30ft. by 8ft. 6in., by Adamson, 1900, w.p. 80 lb.

2 27ft. by 7ft. 6in., by Holdsworth and Co., 1887, w.p. 75 lb.—Can be seen on site.—JOHN CROSSLEY and SONS, Ltd., Dean Clough Mills, Halifax. P6530 G

FOR IMMEDIATE DISPOSAL.—

OFFERS REQUIRED for 25 MACHINE TOOLS and PARTS, now warehoused in S.E. district.

Full particulars on application to Box F. J. W., c/o C. J. Walker's Advt. Agency, 28, Coleman-street, E.C. 2. 879 G

FOR SALE, Excellent Second-hand, Standard Gauge STEAM LOCOMOTIVE, four wheels coupled, 14in. cylinders by 22in. stroke, by Hawthorn, Leslie and Co.; insured 160 lb. w.p. Low price to clear.—E. H. NEAL and CO., Broadway, Ealing, London, W. 5. 799 G

FOR SALE, LANCASHIRE BOILER, 30ft. by 8ft. 6in., by W. Arnott and Co., Ltd., of Coatbridge; complete with Fittings and Injector. Recently surveyed and passed for a working pressure of 140 lb. to the square inch.

Apply, GEORGE W. HORNER and CO., Ltd., Chester-le-Street, County of Durham. P6532 G

FOR SALE, ONE RIVET-MAKING MACHINE, revolving table to make rivets 4in. to 7-8in. diameter. Can be seen by appointment.—Apply, BRAITHWAITE and CO., Engineers, Ltd., West Bromwich. 794 G

FOR SALE, the Largest Stock in the Country of Unused WROUGHT IRON SCREWED and SOCKETTED PIPES, both brand new and ex-Army stocks, as follows:—

11,000 feet, 6" Steam.
100,000 feet, 6" Water.
135,000 feet, 4" Water.
47,000 feet, 3" Water.
12,000 feet, 3" Steam.
40,000 feet, 2" Water.
30,000 feet, 1½" Water.
Also 1", ¾", ½", 3/8".
100,000 feet of 4" Solid-drawn Steel with loose flanges.
5500 feet, 8" Weldless Steel S. and F.
6000 feet, 6" Ditto.
GEORGE COHEN, SONS and CO., 800, Commercial-road, London, E. 14. 880 G

FOR SALE, THEODOLITES, DRAWING INSTRUMENTS, SECOND-HAND. CLARKSON'S, 338, High Holborn, W.C. (Opposite Gray's Inn-road).

FOR SALE, LEVELS, DRAWING INSTRUMENTS, SECOND-HAND. CLARKSON'S, 338, High Holborn, W.C. (Opposite Gray's Inn-road). Ex. G

FOR SALE, 8ft. 6in. Diameter by 20ft. LANCASHIRE BOILER, with mountings and furnace fittings for hand firing, insured for 160 lb. working pressure; good condition.—Situated at HARWORTH COLLIERY, Bawtry, Yorks., where offers should be sent. 844 G

FOR SALE, 12 H.P. Single-cylinder HORIZONTAL STEAM ENGINE, by Worssam, with 7ft. fly-wheel and Tangye automatic oiler; and 12ft. by 5ft. Galloway Tube BOILER, by Worssam. For immediate disposal at £100 the two. In running order, but superseded by electric power.—NEWSON and CO., 28A, Upper George-street, London, W. 1. P6524 G

FOR SALE

NEW "FRIESTMAN" CRANE GRAB DREDGER FOR SALE, 10-Ton, "EE" Size, Open Type PONTOON DREDGER, all replete with spares and 45 cubic feet Grab. Ready packed for shipment. Bargain price for immediate clearance.—R. H. NEAL and COMPANY, Ealing, London, W. 5. 770 G

FOR SALE, 150 H.P. CROSS COMPOUND DAVEY-PAXMAN ENGINE, cyls. abt. 11½in. and 20in. by 27in. stroke; drop valve gear and fittings; new 1919. Fixed London.—WILLIAMS and SONS, 37, Queen Victoria-street, London. 888 G

FOR SALE.—

ONE PUMPING SET, comprising two-cylinder "Aster" Engine, coupled direct to a 6in. Fulsometer Centrifugal Pump; capacity 700 galls. per minute to 50ft. head.

ONE 50 K.W. Belt-driven DYNAMO, by Newtons, 440/460 volts D.C., 780 r.p.m., complete with Switchboard.

ONE 20 K.W. Belt-driven DYNAMO, by Siemens Bros., 220/230 volts, 800 r.p.m., D.C.

ONE 35 K.W. ELECTRIC GENERATOR, by the Phœnix Dynamo Mfg. Co., Bradford, 220 volts D.C., 152 amps., 850 r.p.m.

ONE 35 K.W. ELECTRIC GENERATOR, by the Brush Electrical Co., Loughborough, 220 volts D.C., 153 amps., 1100 r.p.m., complete with Slide Rails and Pulley.

1414ft. run of NEW 12in. CAST IRON DOUBLE-FLANGED PIPE, flanges faced and drilled to B.S.T. No. 2.

ONE NEW 12½in. centre LATHE, 10ft. 6in. gap bed, S.A., S.S., and S.C., by Robson; complete with countershaft.

ONE 26in. VERTICAL DRILLING MACHINE, to drill 12in., automatic and hand feeds, back-geared.

ONE Belt-driven NIBBLING MACHINE, by Burton, Griffiths; admits 26in. in mouth, overhead motion.

ONE Belt-driven EMERY FACE GRINDER, by Burton, Griffiths.

ONE Churchill 18in. DOUBLE-DISC GRINDER.

TWO No. 5 and ONE No. 21 ARBOR PRESSES.

STANLEY ENGINEERING CO., Bath. Ex. G

FOR SALE.

16in. SIX WHEELS COUPLED LOCO., built 1918, 160 lb. pressure.

12in. SIX WHEELS COUPLED LOCO., rebuilt this year, 160 lb. pressure.

5-TON WILSON CRANE, with shunting carriage.

TWO NEW HONE GRABS, 1 cub. yd. capacity.

FRANK EDMUNDS, HARLASTON, STOKE-ON-TRENT. Ex.

FOR SALE.

7000 CREOSOTED SLEEPERS, Good Second-hand, with chairs attached.

15,000 New CREOSOTED SLEEPERS, second quality.

250 JIM CROWS.

20 PLATELAYERS' BOGIES.

30 SETS of SWITCHES and CROSSINGS, of various angles and sections.

100 SETS of 2ft. gauge SWITCHES and CROSSINGS.

50 2ft. gauge SIDE-TIP WAGONS.

800 TONS Second-hand BULL-HEAD RAILS.

Large number of other lots.

Send for catalogue.

THOS. W. WARD, Ltd., ALBION WORKS, SHEFFIELD. Ex.

HIGH-SPEED STEEL.

APPROXIMATELY 400 TONS.
ENTIRE GOVERNMENT STOCKS.
LOW PRICE FOR QUICK SALE.

WM. POULTON AND CO.,

30, WILSON-ROAD, SHEFFIELD.
Tel., West 127. Telegrams, "Winner." 777 G

LANCASHIRE BOILER (One Tinker-Shenton), 32ft. by 7ft. 6in., complete with all fittings, two safety valves, stop valve, pressure gauge, &c.; in perfect condition and done very little work; seen Liverpool; price £245 or close offer.

GAS PRODUCER (Onet), by the Power Gas Corporation, to gasify 50/60 tons of coal per week. Was erected to gas fire furnaces, but never lit. Complete with charging hopper, stacing, coal storage platforms and tools, with detachable stourbridge lining, gas main and stop valve, fire-clay lined; £240 or close offer.—ROWE BROS. and CO., Ltd., Pall Mall, Liverpool. 886 G

LANDIS No. 1½ INTERNAL GRINDER, Graduated heads and feeds, on cabinet bed with countershaft.—THOMAS MITCHELL and SONS, Ltd., Bolton. 803 G

ONE Practically New "Lubecker" TRAVELLING GRAVEL "DREDGER-LIFTER" A 36ft. "Dredger-Lifter," buckets (spaced 4ft. apart) on endless chain on rising and falling jib, by Messrs. Taylor and Hubbard, Leicester. Capacity about 300 tons per working day. Driven by Enclosed Type Vertical 2-Cylinder Compound High-speed Steam Engine No. E. 906, by Messrs. E. S. Hindley and Sons, Bourton, Dorset, and fitted with governor, flywheel, clutch gear and a "Sirius" steam trap. The steam is generated by a Cochran Vertical Boiler, built 1915 (No. 6777), working pressure 125 lb., fitted with injector, usual fittings and 2 water tanks. The whole enclosed and arranged for a track 4ft. gauge. Price £1200 net, as and where it now stands near Gloucester; has not been used since the Armistice. A "track" supplied if required, consisting of steel flange rails, 75 lb. per yard, British Standard pattern, with fishplates, bolts, nuts, spikes and Wanny rectangular sleepers, 18ft. by 12in., by 6in.—For further particulars apply, THE BUTE WORKS SUPPLY CO., Ltd., Cardiff. 771 G

PORTABLE RAILWAY MATERIAL, WAGONS, TRACK, CROSSINGS, TURNTABLES, &c.—PLEASE NOTE.—We are now in a position to SUPPLY NEW MATERIAL of superior make from stock at lowest prices.—JOSEPH PUGSLEY and SONS, Ltd., Cattybrook Ironworks, Lawrence-hill, Bristol. Telegrams, "Piston, Bristol." Telephone No. 139. 885 G

PRESS, ONE NEW HYDRAULIC BALING, Capacity 200 tons; cost about £4500; offers invited.—The LIQUIDATOR, Scottish Mesopotamia Corporation, Ltd., 31, George-street, Edinburgh. 866 G

RAILWAY MATERIAL.—NEW and SECOND-HAND CREOSOTED SLEEPERS and CROSSING TIMBERS from large stocks. All sections of NEW and SECOND-HAND STEEL RAILS with accessories.

E. H. NEAL and CO., Contractors' Engineers, 53 The Broadway, Ealing, London, W. 5. 800 G

RICHARDS' SIDE PLANER, 5ft. by 12in. by 12in., two T-slotted tables, double belt drive, countershaft.—THOMAS MITCHELL and SONS, Ltd., Bolton. 803 G

SALE, Cochran VERTICAL TUBULAR BOILER, 16ft. by 7ft. 6in., 720 square feet heating surface, 100 lb. pressure, equal new, with fittings.—Apply, F. BAKER and CO., Ltd., Albion Works, Cardiff. 766 G

STEEL CHIMNEY, 80ft. by 4ft. 6in. Dia., Plates about ¼in. thick, in nine sections, with base-plate; excellent condition.—JOSEPH PUGSLEY and SONS, Ltd., Cattybrook Ironworks, Lawrence Hill, Bristol. 850 G

For continuation of For Sale Advertisements see page 3.

NOVEMBER.

Automatic Train Control.

TWICE in one week in August last collisions occurred which led to the Government Inspectors remarking in their respective reports on the mishaps that the accident under review was another illustration of the class which would have been prevented had an automatic train stop been provided at the signal which the driver failed to observe. One of the accidents was that at Milton Range halt, Gravesend, which was the subject of a Note for October. The other happened on August 26th at Northampton, London and North-Western Railway, the report on which was issued on the 15th of November. In the latter case the driver of a local passenger train started out of a bay line and was warned by a distant arm on the starting signal that the home signal for No. 3 box, 437 yards further on, was at "danger." As in the Gravesend case the driver had not been stopped at this place before, and did not expect to be pulled up on this occasion. That his overlooking the condition of the home signal was not a casual omission is suggested by the fact that he also failed to see an empty wagon train in front of him until he was within eighty yards of it. The tail of this train was 415 yards past the home signal, and the passenger train struck it at a speed of 10 to 12 miles per hour. These somewhat frequent references to the necessity for automatic train control are noteworthy. Each accident that occasions such a remark to be made furnishes the Ministry of Transport with grounds for proceeding to make the provision of automatic train control one of its Requirements, and if the companies are anxious to avoid that expense they must, it would seem, take some steps to make the over-running of signals a more serious offence.

Gliders.

THE possibility of using gliders as a practical means of communication over regions where vertical air currents exist has been discussed during the month in connection with the trials of such apparatus which are to be held at Biskra, on the border of the desert to the south of Algeria. It naturally follows that so long as the sandy desert is heated by the sun's rays the air ascends vertically, and the currents may vary according to the configuration and nature of the ground. It is stated that vertical currents of 1½ m. per second will be quite sufficient to sustain gliders, which, by taking advantage of the variations, would be able to travel in a practically straight line at fairly high speeds. It is known that the upward currents have sometimes a velocity of 1.6 m. per second. A French meteorological mission is being sent to Biskra to investigate this question of vertical air currents and obtain all the data possible in time for the glider competition so that experiments may be made in flying over the desert. It is assumed that with the aid of these warm currents an apparatus should be able to glide at a speed of 30 to 35 miles an hour. The flight of gliders across the desert, with landing stages along the way, is regarded by many experts as quite within the range of probabilities.

The Grouping of the Railways.

ON the 16th of the month meetings of the proprietors of the South-Eastern, London, Chatham and Dover and of the London, Brighton and South Coast, and on the 17th of those of the London and South-Western Railway were held to approve the terms for the amalgamation of these companies into the Southern Group, to be known as the Southern Railway Company. On the latter day also were held the necessary meetings of the Great Eastern, Great Northern, Great Central, North-Eastern, North British, and Great North of Scotland for a similar purpose as regards the Eastern, North-Eastern and East Scottish Group, which is to be known as the London and North-Eastern Railway. The grouping of the North-Western, Midland and West Scottish companies has not made the same progress. Terms have been arranged with the London and North-Western—which had already amalgamated with the Lancashire and Yorkshire—the Midland, Furness, Glasgow and South-Western and Highland and the respective proprietors approved the scheme at meetings on the 24th. This group of companies is to be known as the London, Midland and Scottish. As yet the consent of the North Staffordshire and Caledonian to join the group has not been obtained. If it is not secured by the end of the year the Ministry of Transport can proceed to make its own scheme for the amalgamation of these two companies in the group. Such amalgamation is, under the Railways Act, mandatory and not permissive. We do not know why the two companies named have not come to terms, but as regards the North Staffordshire it is easy to imagine that the price offered is considered too low. That line may be one of the smaller systems, but it is in a remarkably strong position. It is financially sound, has been well maintained, its business prospects are excellent, and, moreover, its territory is compact and inviolate. Other companies come within its borders, but only by running powers. Whilst it may be, as Sir Guy Granet remarked at Derby last Friday, a reflection upon the companies if they are unable to settle their own affairs without outside assistance, it has to be remembered that a few of the companies, of which the North Staffordshire is one, have had no desire for amalgamation. They have not only nothing to gain thereby, but stand to risk much.

State Monopolies.

THE State monopolies are so entirely discredited in France that there is no longer any question of adding to their number, but the Government is doing nothing to suppress those that already exist. They have been attacked time after time, and no greater condemnation has been passed upon them than the reports of experts presented at a conference held in Paris during the month, when it was shown that the lack of industrial progress and business enterprise would mean, in the case of a private venture, immediate failure. In some cases obsolet-machinery is purposely employed to keep a largee number of hands at work, and no one knows whar the products cost, although the State is able to makt money out of poor quality articles by fixing its owe price. The reports affirmed that the State wouln derive a far larger revenue by suppressing the monoe polies and imposing taxes on the products, as is dond in many other countries. Especially is this the case with the telephone service, which is very dear and unsatisfactory. The conference concluded that the State methods are very inefficient and uneconomical, but there is little reason for believing that this further condemnation of the monopolies will, for the time being at any rate, imperil their existence, which rests upon political influences that are far stronger than the public interest. The most uncompromising supporters of monopolies are the operatives themselves. Being well organised, they resist every attempt to hand them over to private enterprise, and recently the Minister of Finance assured them that the Government would not suppress the monopolies. As, however, Governments change, and the public opposition to the monopolies is growing stronger, the time must come when the whole system will be abolished.

Tariffs and Trade.

OF the many influences that militate against international exchanges one of the most serious is the attempt by certain countries to maintain the fiscal tariffs at a level corresponding with the fluctuations in money values. The matter has been taken up by the League of Nations, which last month presented a communication to the various Governments recommending that the import duties should be adjusted over fairly long periods. At present the tariffs are changed with such bewildering frequency that the importer rarely knows what he has to pay upon foreign goods, and he is entirely in the dark as to possible variations in the future. The system of coefficients may be logical in a sense, so long as it is regarded as a method of adjustment within certain limits, but in France the liberty accorded to the Government to modify the coefficients at any moment has had the effect of seriously complicating the situation, while it must be admitted that in many cases the coefficients have been taken advantage of as a means of strengthening the protection of certain industries. The system has proved so detrimental to foreign trade that the French Government has decided to replace it by a new permanent fiscal policy which will probably be put into operation during the first half of the coming year. In the case of Belgium also the situation has been complicated by the introduction of higher duties, prepared as a means of negotiating treaties with other countries, like France, which are insisting upon a strict reciprocity. As Belgium has little to offer under the existing tariff, she is raising the import duties mainly as a means of giving something in return for concessions from France. If the recommendations of the League of Nations should be taken into account by the countries concerned they will at least remove one of the factors of trade instability.

Pile Driving Vibrations.

AN action involving a matter of interest to engineers and others was concluded during the month in the Chancery Division, when Mr. Justice Astbury pronounced judgment in the case of Hoare and Co., Limited, *v.* McAlpine. In this action the plaintiffs claimed a declaration that the pile driving operations carried out by Sir Robert McAlpine and Sons in connection with the construction of Adelaide House on the south side of Lower Thames-street, near the site of old London Bridge, had caused damage to their property, the Steam Packet Hotel, by subsidence and vibration, and sought an injunction restraining them from continuing the damage. The plaintiffs' counsel stated that 671 piles more than a foot square and from 24ft. to 38ft. in length had been already driven through about 16ft. of made ground into the London clay, and that many more remained to be placed. When a certain depth had been reached the clay acted, he said, like a fluid in transmitting vibrations. Work was begun by the defendants in November, 1920. The hotel at that date, although one hundred years old, was in good condition after recent repairs, but by June, 1921, as a result, it was alleged, of the pile driving operations, it was reduced to a condition which was such that the City Corporation served a notice on the owners that it was dangerous. Shoring up was resorted to, but the damage continuing, notice was served in January, 1922, that the building would have to be pulled down from a height of four or five storeys to the first floor. The defendants denied that the pile-driving operations had damaged the building, and that any vibration so caused was incapable of causing injury to property. The Judge, however, held that the evidence clearly showed that serious damage to the plaintiffs' hotel had been caused by the pile driving, and had been responsible for the issuing of the order to pull down the building. The plaintiffs would therefore receive the declaration sought and there would be an inquiry to determine the amount of the damages.

The International Electrotechnical Commission.

AT the request of the British National Committee of the International Electrotechnical Commission, meetings of the Advisory Committee of that body took place in Geneva from the 20th to 26th of the month, when the situation as regards an international basis of rating electrical machinery was reviewed. From a brief report that has just reached us, it appears that fifty-eight delegates were present representing in all eleven nations, including Germany. Mr. Roger T. Smith acted as chairman of the British delegation to the Advisory Committee on Rating. The subjects dealt with were the rating of electrical machinery, graphical symbols, screw lamp caps and holders and standard pressures and regulations for overhead transmission. So far little information is available as to the conclusions which have been arrived at, but we are able to state that after four days' discussion it was eventually agreed to recommend all the national committees of the International Electrotechnical Commission to consider the acceptance of the 40 deg. rating with overload as an additional international standard. Good progress has, it seems, also been made with the work of the other advisory committees, and we hope to deal with their recommendations in another issue. The facts which led the British National Committee of the International Electrotechnical Commission to call for these meetings are worth relating. At a meeting of the Commission held in 1913 it was decided that the rating of electrical machines should be based on a 50 deg. Cent. rise of temperature with no sustained overload. Shortly afterwards the British Engineering Standards Association issued its standardisation rules, which were based entirely on the International Electrotechnical Commission's rating, and these rules covered all types of electrical machinery, with the exception of traction motors. But after the war British electrical engineers found that they were in many cases unable to conform to those rules. More than 95 per cent. of the motor and generator business demands a sustained overload, which generally amounts to 25 per cent. for two hours. The British Engineering Standards Association was therefore faced with the necessity of departing from the recommendations of the International Electrotechnical Commission, and in order that the matter might be properly discussed the Geneva meetings were arranged.

The Motor Shows.

IF proof were needed that the motor car is no longer an article of luxury or a rich man's toy none better could be produced than the interest which the public takes in the annual exhibitions promoted by the Society of Motor Manufacturers and Traders. The value of these shows to the great British motor industry from an advertising point of view can scarcely be over-estimated, while as an educational medium it is difficult to assess their importance.

Without bringing to light any really striking developments in automobile design, the recent exhibitions demonstrated very adequately that in spite of its vicissitudes, past and present, there is still plenty of vitality in the British motor car industry. In comparison with the products of America and the European countries, those of this country come out well. In one respect British manufacturers have now a decided lead. We refer to the small-power car. These vehicles represent a branch of the motor industry which has not so far been touched in America and only slightly on the Continent. The great demand for the small car has been brought about in this country largely by the depressed industrial conditions, and the value which is now offered is remarkable when the number of accessories which are provided on the modern car are taken into consideration. It is very gratifying to learn that the amount of business which was done at the recent shows exceeded expectations, and that some of the exhibitors will have more than they can do to cope with the orders now on their books.

The French Arsenals.

THE debate in the Chamber of Deputies upon the reorganisation of the arsenals, whereby it is hoped to realise economies of 30 to 35 million francs a year, has enabled the Minister of Marine to explain the policy of the Government, which aims at concentrating effort upon the two leading arsenals and utilising the others in association with private shipyards, so that they may be readily organised in time of war. The idea of handing the arsenals of Lorient and Rochefort over to private firms has been abandoned for the time being through the failure to obtain suitable offers. The arsenals that are to be kept in a high state of efficiency are Brest and Toulon. Cherbourg and Bizerte will become naval bases, and the other arsenals will be regarded as auxiliaries which will be just kept going so that they may be utilised in time of hostilities. The slips for the construction of submarines will be maintained at Cherbourg, and the number of hands at Bizerte will be reduced to what it was before the war, while at Lorient it is intended to make more profitable use of the high-class plant and machinery with which the port is equipped. Rochefort will be suppressed and the Guérigny armour plate and chain works, which have been closed down since 1919, will be made over to private enterprise if an acceptable offer is forthcoming. No more armour plates will be required, as the 8000-ton cruisers under the new programme will be built for speed and will have no protection, and the chain manufacture will be transferred to Indret. In a word, the State has no longer the intention of running the arsenals in competition with private industry, but, except in the case of Brest and Toulon, will use them mainly for repairs and other work, and also for organising the private industry in time of war.

International Telephony.

MUCH useful information concerning telephony was given in Mr. Frank Gill's presidential address delivered before the Institution of Electrical Engineers on the second day of the month. Although it is, of course, well known that the telephone systems in America are of a gigantic character, it was perhaps not generally realised before Mr. Gill called attention to the fact that, comparatively speaking, Europe is in a very backward state as far as long-distance communication is concerned. There is, however, no reason whatever why the service in Europe should not be extended in a somewhat similar fashion to that in America. From the fact of its denser population and less distant cities, Europe enjoys advantages over the United States, and these should make for much greater development of through business than she now has. Mr. Gill's suggestions in respect of how this through business should be brought about were thoroughly sound. Obviously, the business must be handled as a complete unit, if it is to be efficiently done, and there is much to be said for the idea of deputing a body to do for all European nations that which no one nation can do for itself. With sectional, non-unified control over the various portions of the through business, it is not possible to design, construct and operate through lines of communication in a manner capable of meeting the needs of the public. If, as Mr. Gill explained, it was possible for nations to agree on unity of control for the purpose of the war, it ought not to be beyond their powers to agree to a unity of control for the efficient working for the through telephone business.

Short Histories of Famous Firms.

Contributed by E. L. AHRONS, M.I. Mech. E.

No. XV.*

MESSRS. NEILSON AND CO. (SUBSEQUENTLY NEILSON, REID AND CO.), HYDE PARK LOCOMOTIVE WORKS, GLASGOW.

THIS celebrated firm, which is now one of the partners in the North British Locomotive Company, Limited, was founded in 1837 by Mr. Walter Montgomerie Neilson, the son of Mr. J. Beaumont Neilson, who in 1828 invented and patented the hot blast, which was first used for a blast-furnace at Clyde Works. The new firm of Neilson and Co. began operations as builders of stationary and marine engines at Hyde Park-street, Finnieston, Glasgow. Shortly afterwards, Mr. Neilson's attention was drawn to the large field for the manufacture of locomotive engines offered by the advancing construction of railways. In 1840 there were four or five small firms in Scotland which had taken up this branch of engineering. Of these, two—Messrs. Stark and Fulton and Messrs. T. Edington and Sons—were operating in Glasgow, and the others—Messrs. Stirling and Messrs. Kinmond, Hutton and Steel—had works at Dundee. With the exception of the last-mentioned firm, which continued locomotive building until about 1848, the others either disappeared or devoted their energies to general engineering work after 1842, and Messrs. Neilson eventually remained for some time the only locomotive builders in Scotland.

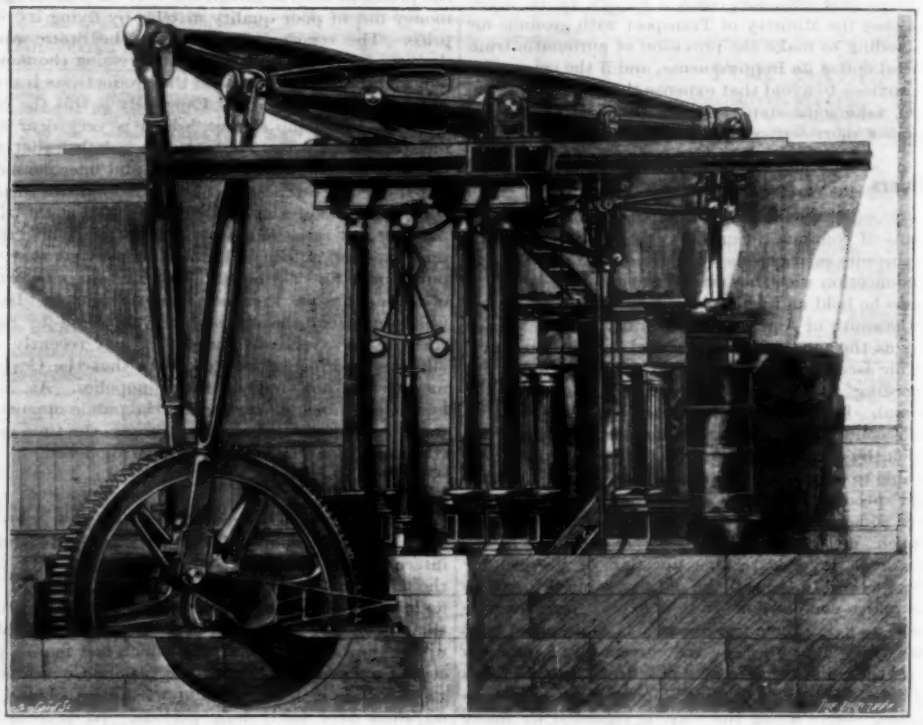


FIG. 1—STATIONARY ENGINE FOR HAULING TRAINS UP THE COWLAIRS INCLINE, 1842

Of the stationary engines built by the firm the most celebrated was the large double beam engine constructed in 1842 for hauling the trains on the Edinburgh and Glasgow Railway up the Cowlairs incline from Queen-street Station, Glasgow. This engine—illustrated in Fig. 1—worked the endless wire rope, which was attached to the front of ascending locomotives, for a period of more than seventy years, and was withdrawn from service only about ten years ago.

No particulars of the earliest locomotives built by the firm are available. The first three were small four wheels coupled engines with 4ft. wheels and 14in. by 20in. cylinders for the Glasgow and Garnkirk Railway, built in 1843. Until about 1855 the manufacture of stationary and marine engines continued side by side with the construction of locomotives, but at the end of that period the business in the former was given up and the firm devoted its energies entirely to locomotive building. With the exception of a few small tank engines for the Cockermouth and Workington Railway, and the Redruth and Chacewater Railway, the output during this period was confined to the execution of orders for the various Scotch railways. In 1855–7 several engines were exported to Nova Scotia, and thus began the subsequent vast export trade to all countries in the world for which the firm is celebrated. The year 1858 saw the first locomotives exported to India, the order consisting of ten 2–4–0 passenger engines for the Bombay and Baroda Railway. Fig. 2 is interesting as showing a type of early Indian passenger engine with single driving wheels which Neilson and Co. built in 1860 for the Scinde Railway. The spark-arresting chimney and the peculiar cab were features of former practice on the Indian railways.

The first order of importance for an English railway consisted of twenty 2–4–0 engines with outside cylinders 18in. by 24in. and 6ft. 1in. coupled wheels. They were constructed in 1859–60 for the Eastern Counties Railway to the order of Mr. Robert Sinclair, and were illustrated and described in "Recent Practice in the Locomotive Engine" (1860) by D. K. Clark and Zerah Colburn. The fire-box casing in this design was flush with the boiler barrel, and the dome was placed over it. The position of the dome over a flush fire-box casing was characteristic of nearly all Messrs. Neilson's early engines, and was in direct contrast to those built at that period by Messrs. Sharp, Stewart and Co., who preferred a raised fire-box casing, and placed the dome near the chimney, or on the middle of the boiler barrel.

The year 1859 also saw the appearance of the first engines sent by the firm to Ireland in the shape of three 2–4–0 saddle tank engines for the Cork and Youghal Railway, afterwards amalgamated with the Great Southern and Western Railway.

The activities of the firm had now reached a stage when new premises were necessary, and an excellent site was found at Springburn, on the north-eastern side of Glasgow. The works were laid out with a view to future extensions, and carefully planned so that future additions would not interfere with the original scheme of arranging for the work to pass through from the stage of raw materials to that of finished products with a minimum of handling. The new premises were opened in 1860, and the firm took with it the original name of Hyde Park Works.

Fig. 3 shows a 0–4–2 mixed traffic engine built in 1861 for the Dundalk and Enniskillen Railway, of a type largely used on the Irish railways for many years. Another 0–4–2 engine of 1861 with outside cylinders 16½in. by 22in. and 5ft. wheels, for the Caledonian Railway, is shown in Fig. 4. Messrs. Neilson built a large number of engines of this type for many of the Scotch railways; it was a characteristic design which was in great demand north of the border, though it rarely penetrated into England. Figs. 3 and 4 both show the type of boiler and dome used on most of Messrs. Neilson's engines of that period.

A very unusual engine was built by the firm in 1862. This was Mr. Nathaniel Grew's locomotive for hauling sledges over ice in Russia. The driving wheels were at the rear, and the leading end of the engine was carried on a sledge instead of on wheels. It was described and illustrated on page 101 of Colburn's "Locomotive Engineering."

At the London Exhibition of 1862 Messrs. Neilson exhibited the fine express engine—see view No. IV., page 580—of Mr. B. Connor's Caledonian type with 8ft. 2in. single driving wheels and 17½in. by 24in. cylinders. It was the 850th engine of Neilson's build, and was exported to Egypt for the State railways, for which country two similar engines were subsequently built in 1865. These three engines continued in service with their original boilers until 1894–5, when they were broken up at Cairo.

In 1862 the first engines built by the firm for the European Continent were exported. Twelve of them

* No. XIV. appeared August 18th.

were 2–4–0 passenger tender engines, with inside cylinders 16in. by 24in., and 5ft. 3in. coupled wheels, for the Utrecht and Zwolle Railway, which now forms part of the Dutch Central Railway, and nine of them, rebuilt as tank engines, are still at work. In 1863 seven 2–4–0 passenger and seven 0–6–0 goods engines were exported to the Valencs and Ponferrado Railway of Spain. They combined many features of Messrs. Neilson's practice with others of foreign—notably French—design. In both types all the wheels were in front of the fire-box, and the French pattern of Crampton regulator outside the boiler with external steam pipes was used. The goods engines, which had 4ft. wheels and 18in. by 24in. cylinders, are illustrated on plate 12 of Colburn's "Locomotive Engineering." It speaks well for the design and workmanship that all fourteen engines were quite recently—and may still be—at work on the Northern Railway of Spain, having undergone hardly any alterations.

The partners in the firm at this time were Mr. Neilson and Mr. Henry Dubs, but in December, 1863, the latter withdrew in order to found a new locomotive building establishment at Polmadie, on the south side of Glasgow. It was then that Mr. James Reid joined Mr. Neilson. Mr. Reid had had a long engineering experience with Messrs. Caird and Co., of Greenock, and afterwards with Messrs. Neilson. Subsequently he left Glasgow to join Messrs. Sharp, Stewart and Co., of Manchester, where he became general manager, and on the retirement of Mr. Dubs, Mr. Neilson asked him to return to Glasgow as a partner in the Hyde Park establishment. On Mr. Neilson's retirement in 1878 Mr. Reid became the sole proprietor of the firm.

In 1864 twenty express engines with single driving wheels 6ft. 6in. diameter, and outside cylinders 15in. by 22in., were built for the East Indian Railway. Till then the firm's output had been principally confined to locomotives for Scotch, Irish, and Indian railways, and the total built had exceeded 1000. From that time they succeeded, owing to Mr. Reid's business experience at Manchester, in gaining a hold on the English market, which was constantly maintained and increased. Twenty 2–4–2 tank engines with trailing Bissel truck axles were built in 1864 to Mr. Sinclair's designs for the Great Eastern Railway. Orders for goods engines for the Great Northern and the Manchester, Sheffield and Lincolnshire Railway followed, including a number of Sturrock's steam tenders for both railways. In 1866 the tank engines shown in view No. X., page 580, were built for the Great Northern (five) and London, Chatham and Dover railways (fourteen engines). These had 5ft. 6in. coupled wheels, and trailing wheels fitted with W. Bridges Adams's radial axle-boxes. The cylinders were 16½in. by 22in. For many years these engines, which were popularly known as the "Scotchmen," were the smartest running tank engines in the London district.

In 1866 the first engines made by the firm for Australia were exported. The order consisted of eight small 0–4–2 tender engines for the Queensland Government railways, 3ft. 6in. gauge, and were amongst the earliest engines to work in that colony. The same year saw the first engine sent to Greece, for the Athens and Piræus Railway. It was followed, in 1868, by an order for ten main line engines for Russia. Twenty-five 4–4–0 passenger engines with 5ft. 1in. coupled wheels, and 16in. by 26in. cylinders were built in 1868 for the Grand Trunk Railway of Canada, and included many American features in their design.

Italy was the next foreign country from which the firm succeeded in obtaining orders, and between 1869 and 1875 thirty-eight 2–4–0 passenger and twenty-two 0–6–0 goods engines were built for the Southern (Calabro-Sicilian) railways of that country. Nearly all these engines are still at work.

In 1870 Messrs. Neilson constructed for the Midland Railway, to the designs of Mr. M. Kirtley, thirty of the most celebrated express engines—see view No. I., page 580—that have ever run in this country. As built they had 17in. by 24in. cylinders, coupled wheels 6ft. 8in. diameter, and a wheel base of 16ft. 6in. The boilers, which carried 140 lb. pressure, had a heating surface of 1097 square feet. The weight in working order was about 35½ tons. They proved such excellent engines that when the Midland line from Settle to Carlisle was opened in 1876, Mr. S. W. Johnson decided to employ them on the fast Scotch expresses, and for this purpose new cylinders, 18in. by 24in. (some 18in. by 26in.), were fitted, in addition to larger boilers, the framing and motion remaining as built. For twenty years afterwards they bore the principal share of the burden of the Scotch expresses, and one of them—No. 815—accomplished the best performance, within the writer's experience, over the severe gradients of the Settle and Carlisle road in running from Carlisle to Aisgill summit, 48¼ miles, in 59 minutes, practically uphill nearly the whole way, the last 11 miles rising at the rate of 1 in 100. The load behind the tender was 130 tons. On December 24th, 1910, forty years after it had been built by Messrs. Neilson, the same engine was piloting the night Scotch express from Leeds to Carlisle, when the train ran into two light engines at Aisgill with disastrous results. This was the last journey made by one of the most famous engines on the line, for it was so badly damaged that it had to be broken up. Of the original thirty engines, twenty-one were still in use at the end of 1921 on secondary services after fifty-two years of the hardest work, and it may safely be said that their continuous record on fast passenger trains has never been beaten.

Another celebrated class of express engine built by the firm is illustrated in view No. V, page 580. Of these, ten were built by the firm in 1873 to Mr. Edward Fletcher's design for the North-Eastern Railway. They had 7ft. coupled wheels, 17in. by 24in. cylinders, 1208 square feet of heating surface, and a weight in working order of 39 tons. For many years they worked the East Coast expresses between York, Newcastle, and Edinburgh, on which they always performed excellent work with loads up to fourteen six-wheeled coaches. Most of them were broken up in 1914 after forty-one years of hard work, having become too light for the greatly increased train loads.

In 1872 the firm executed its first order for the 3ft. 6in. gauge railways of New Zealand, and in 1875 the works output reached 2000 in the execution of an order for tank engines for the Midland Railway. Of the goods engines—see view No. II., page 580—there were thirty built in 1876 for the Midland Railway to the designs of Mr. S. W. Johnson, with 4ft. 10in. wheels, 17½in. by 26in. cylinders, 140 lb. pressure, and a total heating surface of 1202 square feet. All are still in service, and for nearly forty years were employed in working the fastest Scotch express goods trains over the heavy gradients between Carlisle and Leeds.

The year 1878 saw the first engine sent out to Argentina.

The eight-wheels coupled tank engines shown in view No. VI., page 580, of which Messrs. Neilson built forty for the Great Indian Peninsular Railway, were for the purpose of banking on the Ghat inclines. They had 4ft. wheels, and 18in. by 24in. cylinders. In later engines of a similar class the stroke was lengthened to 26in.

In 1879 the firm executed its first contract for the Cape Government Railways (3ft. 6in. gauge). This consisted of 4–4–0 tender and tank engines with 13in. and 14in. by 18in. cylinders, the small size of which may be contrasted with the huge 4–8–2 and Mallet engines now being built for South Africa. The first metre-gauge engines built by the firm for Brazil were exported in 1880.

In 1881–2 the French locomotive builders were crowded out with home orders, and the French railways contracted for a considerable number of engines to be built over here, some of which will be remembered by the various locomotive manufacturers owing to the extremely rigid inspection of relatively unimportant details which they underwent. Messrs. Neilson's share of these orders consisted of twenty engines for the Western of France, and twenty for the Midi Railway. The latter—shown in view No. III., page 580—were 2–4–0 engines of a characteristic design derived from the old Crampton type, in which the connecting-rods drove the trailing axle, and the steam and exhaust pipes were placed externally. The coupled wheels had a diameter of 6ft. 1in., and the cylinders were 16$^{15}/_{16}$in. by 23⅝in. They had Gooch link motion, and the peculiar tender will be noticed.

The 3000th engine was built in 1883 for the East Indian Railway.

The Caledonian Railway 4–4–0 express engines, designed by Mr. D. Drummond, of which ten were built by the firm in 1884, are shown in view No. VII., page 580. They had 6ft. 6in. coupled wheels, 18in. by 26in. cylinders, 1208.6 square feet of heating surface, and 150 lb. pressure. They were very similar to, but had somewhat larger boilers than, the 4–4–0

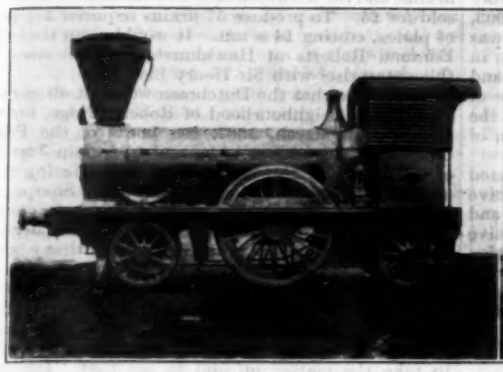


FIG. 2—SINGLE-DRIVER ENGINE FOR INDIA, 1860

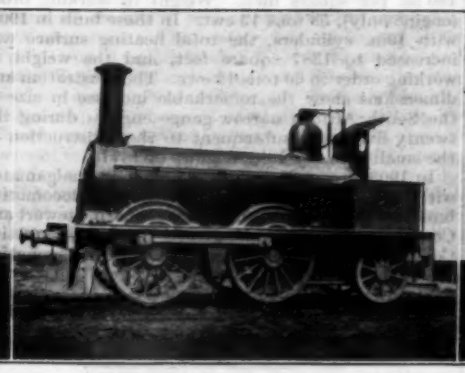


FIG. 3—DUNDALK AND ENNISKILLEN ENGINE, 1861

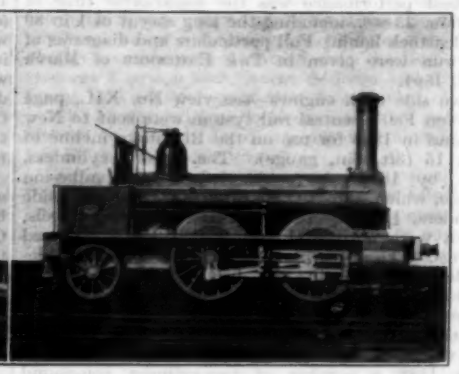


FIG. 4—ENGINE FOR THE CALEDONIAN RLY., 1861

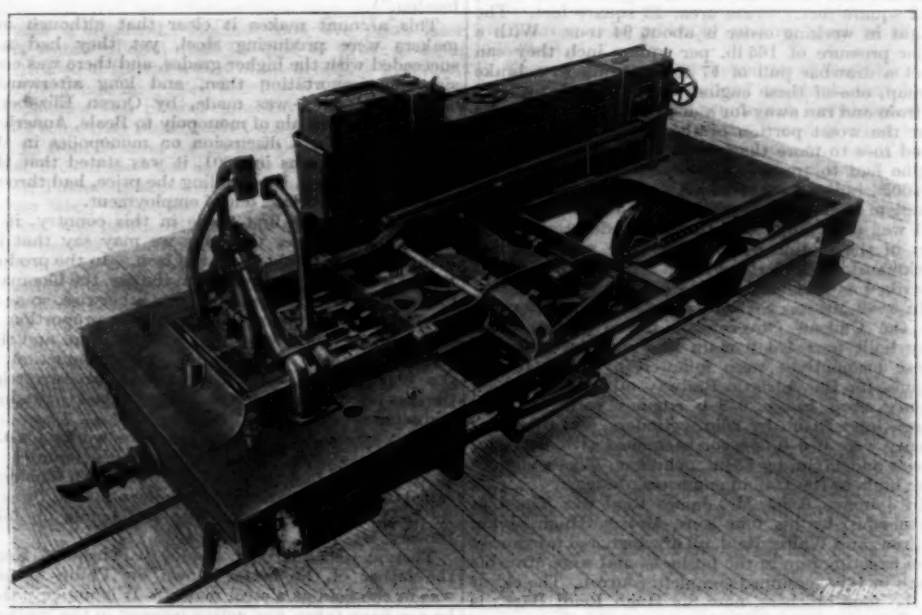


FIG. 5—FRAME OF FELL'S CENTRAL-RAIL SYSTEM ENGINE FOR NEW ZEALAND, 1886

engines which the firm had built in 1876–8 to Mr. Drummond's designs for the North British Railway. The Caledonian engines worked the West Coast expresses from Carlisle northwards until the advent of Mr. McIntosh's larger engines about twelve years later.

In 1886 Messrs. Neilson designed and exhibited at Edinburgh the Caledonian 4–2–2 express engine No. 123, with 7ft. single driving wheels and 18in. by 26in. cylinders. As this celebrated engine has frequently been illustrated it is unnecessary to do so again. During the summer of 1888, when the London to Edinburgh day expresses of the West and East Coast railways were racing one another, No. 123 was always employed between Carlisle and Edinburgh, and with a load of four bogie coaches maintained for the 100¾-mile run a daily average of 107¾ min. Its best performance was the remarkable time of 102 min. 33 sec., including the long ascent of 1 in 80 up Beattock bank. Full particulars and diagrams of this run were given in THE ENGINEER of March 13th, 1891.

Two side tank engines—see view No. XII., page 580—on Fell's central rail system were sent to New Zealand in 1886 for use on the Rimutaka incline of 1 in 15 (3ft. 6in. gauge). The outside cylinders, 14in. by 16in., drove the four-coupled adhesion wheels, which were 2ft. 8in. diameter, and the inside cylinders, 12in. by 14in., actuated the disc wheels, which were horizontal and loaded by compressed springs. The disc wheels grip the sides of a double-headed central rail, also laid horizontally. The motion and gearing are shown in Fig. 5. The gear wheels seen under the crank discs are for coupling together the right and left-hand inside vertical shafts. The weight in working order was 37 tons.

In 1889 a number of two-cylinder compound engines on the Worsdell and von Borries system were built for the Argentine Midland Railway. The passenger engines of the 4–4–0 type with 5ft. 6in. coupled wheels, high-pressure cylinder 16in. diameter, low-pressure cylinder 23in. diameter, stroke 24in., were illustrated in THE ENGINEER of December 27th, 1889. The tenders were carried on two four-wheeled bogies. The goods engines were of the 4–6–0 type, with 4ft. 6in. coupled wheels, high-pressure cylinder 17½in. diameter, low-pressure cylinder 25in. diameter, and stroke 25in.

The Fairlie engines—see view No. XI., page 580—built for the Mexican Railway (4ft. 8½in. gauge) merit special mention, as they have to negotiate gradients of 1 in 25 with numerous reverse curves of 350ft. to 400ft. radius. The wheels have a diameter of 3ft. 6in., the four cylinders are 16in. by 22in., the wheel base of each bogie is 8ft. 3in., and the total wheel base is 32ft. 5in. The distance between the bogie pivots is 22ft. 8in. The tube-heating surface is 1532 square feet, and that of the fire-box 180 square feet; total, 1712 square feet. Grate area, 33 square feet. The weight in working order is about 94 tons. With a boiler pressure of 165 lb. per square inch they can exert a drawbar pull of 17 tons. Owing to a brake mishap, one of these engines once broke loose from its train and ran away for a distance of nearly 7 miles over the worst portion of the road. Although the speed rose to more than 60 miles per hour, and the engine had to traverse the reverse curves of 350ft. to 400ft. radius, one of which describes more than a complete semi-circle, it reached the bottom in safety, and was then stopped without any damage to any part of the motion or framing. The materials and workmanship which stood a test like that can only be described as excellent.

In 1889 Messrs. Neilson executed their first order for the Chilean Government railways, for which they built four 4–4–0 main line passenger engines. These locomotives were followed by forty freight engines for the Adriatic Railway of Italy, of which twenty were heavy 0–8–0 engines with 4ft. 2in. wheels, and 20¾in. by 26in. cylinders, and the other twenty were 0–6–0 fast goods engines with 4ft. 11in. wheels and 17¾in. by 25¾in. cylinders. These engines were built to the Italian engineers' designs.

In January, 1893, Mr. James Reid was joined in partnership by his four sons, Messrs. Hugh, John, Andrew, and Walter Reid, all of whom had previously been assisting him in the business, and who, after his death in 1894, assumed complete control. The eldest of the four brothers, now Sir Hugh Reid, Bart., is at the present time chairman and chief managing director of the North British Locomotive Company, Limited. In 1897 the old title of the firm was altered to Neilson, Reid and Co.

In 1890 an entry was effected into the Japanese market in the form of an order for four 4–4–0 engines for the Sanyo Railway, and from that year onwards a large number of engines were built for the Imperial and other Japanese railways.

Of the subsequent engines built by the firm considerations of space preclude the mention of more than one or two characteristic types. View No. VIII., page 580, shows a 2–8–0 freight engine for the Western Australian Government Railways (3ft. 6in. gauge), of which a number were built in 1896. The coupled wheels are 3ft. in diameter, the cylinders 15½in. by 21in., and the weight of the engine in working order is 58½ tons. Owing to the scarcity of water on the railways of Western Australia, the engines are provided with side tanks in addition to large double bogie tenders.

In 1901 ten large 4–4–0 express engines were built for the Midland Railway to Mr. S. W. Johnson's designs, and one of them was on view at Glasgow exhibition in that year. They had 19in. by 26in. cylinders, 7ft. coupled wheels, and carried 170 lb. pressure. The writer can testify from personal observations to the excellent running which these engines accomplished with heavy expresses between London, Leicester, and Leeds.

View No. IX., page 580, illustrates a heavy 4–8–0 engine built in 1902 for the Central South African Railways. In all, thirty of these were built, some with 18½in. by 24in., and later ones with 19in. by 24in. cylinders. The eight coupled wheels have a diameter of 4ft. The tube-heating surface is 1184 square feet, and that of the fire-box, 131 square feet; total, 1315 square feet. Grate area, 21 square feet. Pressure, 180 lb. per square inch. Weight in working order (engine only), 58 tons 13 cwt. In those built in 1903, with 19in. cylinders, the total heating surface was increased to 1387 square feet, and the weight in working order to 60 tons 12 cwt. The illustration and dimensions show the remarkable increase in size of the South African narrow-gauge engines during the twenty-five years subsequent to the construction of the small 13in. by 18in. engines of 1877.

In 1903 Messrs. Neilson, Reid and Co. amalgamated with the two other Glasgow firms of locomotive builders, Messrs. Dubs and Co., and Sharp, Stewart and Co., Limited, to form the North British Locomotive Company, Limited. At the time of the amalgamation the annual capacity of Messrs. Neilson, Reid's works alone was 300 main line locomotives, or one engine per working day, and the total output of engines had reached about 6350.

The Early History of Steel Making in England.*

By RHYS JENKINS.

THE history of the production of steel in England before Huntsman's invention of cast steel, say about 1750, does not seem to have been the subject of research, and remains obscure. The notes now presented will throw some light, at any rate, on the beginnings of one of our great industries.

That steel was being produced in England in the time of Queen Elizabeth is well known. William Harrison in "A Description of England," printed in Holinshed's Chronicle, 1577, writes: "As for our steele, it is not so good for edge-tools as that of Cullen (*i.e.*, Cologne), and yet the one is often sold for the other, and like tale used in both, that is to saie, thirtie gads to the sheffe, and sixe sheffes to the burden."[1]

This account makes it clear that although our makers were producing steel, yet they had not succeeded with the higher grades, and there was considerable importation then, and long afterwards. This importation was made, by Queen Elizabeth, the subject of grants of monopoly to Beale, Annerley, and others. In a discussion on monopolies in the House of Commons in 1601, it was stated that the monopoly of steel, by doubling the price, had thrown two thousand workers out of employment.

When steel was first made in this country, it is impossible to state. Perhaps we may say that its manufacture is as old as that of iron. In the production of wrought iron direct from the ore, the bloomary might be worked, intentionally or otherwise, so as to produce a material carrying a higher proportion of carbon than was advisable in wrought iron, and this would be steel. Again, after the introduction of the blast-furnace, the finery process for converting the cast into wrought iron might be worked to produce a similar result.

The earliest definite mention of a works for the production of steel that the author has found is in 1523, when we find that John Glande held a tenement called a "Forge of Steel" in Ashdown Forest, Sussex. In 1525, this forge came into the hands of John Bowley, who still held it in 1548.[2]

Then in 1565 Sir Henry Sidney of Penshurst, Kent, the father of the better-known Sir Philip Sidney, was in the field as a steel maker. It is unlikely that he can have taken any active interest in the business himself, for from the year 1556 until his death in 1586, his official duties as Lord Deputy of Ireland and Lord President of Wales, led to his living the greater part of his life away from his home in Kent.

After the Dissolution of the Monasteries, the possession of the Abbey of Robertsbridge, Sussex, came into the possession of Sir William Sidney, the father of Sir Henry. In 1541, he erected an iron furnace and a forge at Robertsbridge, and in the following year another furnace at Panyngridge in the same neighbourhood. At the death of Sir William the property passed into the hands of the son. In 1564, an agent of Sir Henry engaged at Antwerp certain "Dutchmen," Frolycke and Bowde (or Budde) to come over to England and start the manufacture of steel at Robertsbridge. Apparently these men were not satisfied that the local iron was suitable for the purpose, and a furnace was taken in Glamorganshire, near Cardiff. John Bowde and three other Dutchmen were sent there in June, 1565, and in December of the same year 20 tons of "plates" were shipped from Cardiff to Rye. Before September of the next year 69½ barrels of steel had been shipped to London and to Wales. Frolycke and Bowde seem to have made one or more journeys to Antwerp and "Ducheland" to engage other men, and to bring over "anvils, forms," &c., for carrying on the business. Another man, Peter Krisker, brought nine men out of "Ducheland."

These Dutchmen were no doubt Germans from somewhere in the neighbourhood of Cologne, and the process followed would be the finery process, for which the iron from the blast-furnace, instead of being cast into sows or pigs, was cast into thin flat bars here called "plates." The steel was sold in barrels and firkins, and the firkin contained about 950 lb., and was sold for £5. To produce 57 firkins required 27½ tons of plates, costing £4 a ton. It would seem that one Edmund Roberts of Hawkhurst was associated in this enterprise[3] with Sir Henry Sidney.

One judges that the Dutchmen were not altogether liked in the neighbourhood of Robertsbridge, for we find that in March, 1567, the Lords of the Privy Council caused a letter to be sent to certain Justices of the Peace for the County of Sussex, stating that complaint had been made that "John Sharpe, of Robersbridge or nere thereabouts, naming himself a master of fence, hath of late not only beaten diverse Duchemen which hath been employed in that county by the procurement of Sir Henry Sydney, Knight of Th'order (*i.e.*, of the Garter) and Lord Deputye of the realme of Ireland, for the making of steale, but also hath used suche unfitting wordes against them as is not to be suffered." The Justices are required to take the matter up and to see that "the said Duchemen may have no furder juste cause of complainte."[4]

We do not hear anything further of the Robertsbridge works till 1609, when it appears that John Hawes farmed the estate, upon which there were—"a capital mansion—also various buildings for steel makers, wherein were eight steel forges—also one great gate-house called the West Gate, built of lime and stone, and covered with tile, used in part as a dovehouse and in part for the steel makers; also a great gate called the East Gate employed as a storehouse for iron, with a house attached to it for James Lamaye, the hammerman."[5] This is the last account we have of this works, and its terms do not allow us to say definitely that the establishment was still in operation. The fact that the hammerman lived on the spot suggests that if idle it had not been so very long. The circumstances that the West Gatehouse was used in part as a dovehouse and in part for the steel makers is interesting.

Another point may be mentioned about Sir Henry Sidney: in 1566 he was applying in Parliament for an Act for "making steel and plates for armour within the realme." His Bill got through the House of Commons, but did not pass the House of Lords; its provisions have not come down to us.

Another site of steel forges in Sussex was Warbleton; about a mile south of the village, one may still pass from Hammer-lane into Steel Forge Wood. The date at which this works was carried on is not known.

Our next note concerns the invention of the cementation process.

In 1614, William Ellyott and Mathias Meysey obtained a patent for converting iron into steel "by means of a reverberatorie furnace with potts luted or closed to be putt therein containing in them certain quantities of iron with other substances, mixtures and ingredients, which being in the said furnace brought to a proportion of heate doth make or convert the same iron into steele, which steele with other heat temperatures and hammerings to be afterwards given to the same doth make it good and fitt for the uses before mentioned."[6]

There can be no doubt that the cementation process is here described. The patent recites that there is a great demand for steel in England and Ireland for making armour and weapons, scythes, knives, edge tools for carpenters, masons, &c., that the amount now made in the Kingdoms is small in comparison and the steel is of such inferior quality that it is not much used for the purposes mentioned, so that we are forced to rely upon foreign material. Ellyott and Maysey, at the great costs and charges of themselves and their friends, and by the painful labours and endeavours of themselves and others set at work and employed by them, have lately found out and attained unto a certain new way and means never before in known use and practise in England or Ireland whereby iron may be converted into good steel fit for all the uses before mentioned for which the steel ordinarily brought from the parts beyond the seas has been commonly used. The patent was for the term of twenty-one years at a yearly rent of £10.

From the terms of the second clause in the recital just quoted, the author is led to think that the invention was not an importation from abroad, but of native origin and that it originated with Ellyott and Meysey. They were both natives of this country, and there is no suggestion that they employed foreign workmen. A few years later we find them objecting to the grant of another patent for steel and alleging

* Paper read before the Newcomen Society for the Study of the History of Engineering and Technology on November 29th.

that Palmer, one of the petitioners was a Dutchman, which appears to have been the fact. Now had the invention been of foreign origin, had either of the inventors not been natives, or even had foreign servants been employed, Palmer and his friends could hardly have refrained from seizing upon the fact.

It seems to have been recognised generally that the cementation process had taken root in England before it was used to any extent on the Continent, but it was not known whether it had originated in this country or not, nor to what date it went back. This patent must be held to settle both these questions. It is not necessary here to lay stress on the great industrial importance of the invention.

What "other substances, mixtures and ingredients" were put into the pots with the iron is not known. It is to be remembered that the metallurgists of those days had not arrived at the knowledge that the addition of carbon was all that was required. The prevailing idea seems to have been that steel was a purer and more compact form of the metal than wrought iron. By 1693, Dr. Lister had arrived at the conclusion that "iron of itself, however oft soever it is purged and refined, will never become steel," although of iron so purged and refined the best steel doubtless may be made.[7] Most probably the materials were of the same nature as those used for case-hardening, *i.e.*, mainly organic substances, such as the horns and hoofs of cattle, old leather, &c. Case-hardening is described by Theophilus, the monk, in the eleventh century[8]; and Plot refers to it as being a common process in his day, say seventy years after the date of the patent,[9] and the presumption is that it was in use at the date of Ellyott and Meysey's invention, but the writer has no definite evidence to this effect.

It may be, then, that the invention was a development of the case-hardening process, possibly in the light of knowledge acquired from the manufacture of brass. The cementation process had been applied before this to the production of brass from sheet copper and calamine, and it is known that it was being carried on in England ten years before the date of the patent, but there is some doubt whether the manufacture was still being carried on.

It is a matter for regret that nothing is known of the inventors Ellyott and Meysey beyond the record of their inventions. Their works were probably situated in London, then no doubt the largest steel-consuming town in the kingdom, and where, according to a contemporary writer, "at this day the best and finest knives in the world are made."[10]

Ellyott and Meysey succeeded in producing steel, and in 1616 obtained another patent for carrying out the main invention with pit coal instead of wood. This patent gave them more extended privileges; they were granted the sole right of exporting steel, and the importation of foreign steel (except in manufactured articles, plates for armour, sword-blades, &c.) was prohibited upon pain of forfeiture. The patentees were empowered to examine all ships and parcels of steel arriving at any port or haven, and to open any chests, packs, or other bulk whatsoever wherein any steel shall be suspected to be concealed. To compensate for the loss of the Customs duty on the imported material, they undertook to pay the King £293 16s. 8d. per annum (representing the average receipts for three years) and to increase the rent by £50. On the other hand, they were to supply their steel to the public at prices not exceeding sixpence the pound.[11]

In 1617, D. Powell, A. Palmer, and G. More put in a petition for a patent for making steel; this was opposed by Ellyott and Meysey who, in their petition to the Privy Council, state that several examinations of their steel, both before and after the grant of their patent, showed that it was very serviceable, that they had gone to considerable charges in erecting works, and now attempts were being made to discredit their steel. Ellyott and Meysey succeed in having the patent stopped, only to find themselves confronted with more powerful rivals. In May, 1618, they complained to the Privy Council that "contrary to their privilege granted by His Majesty under the Great Seale for the sole making of steele after their invention, one Robert ffloud, Doctor of Physicke, hath entertayned a ffrenchman to practice the same, hath put up ffurnaces, and is now in work notwithstanding his Ma^tie^ inhibition in the L^trs^ Patent."

The clause prohibiting the importation of foreign steel was one of great importance, and the patentees appear to have taken steps to enforce it as soon as it became operative. As, however, they had not succeeded in making the higher qualities of steel, complaint arose. In 1618, the scythe-makers and gunmakers declared that they could get no steel fit for their use. In the following year, the case is put more emphatically, certain cutlers, gunmakers, blacksmiths and locksmiths declaring that the steel of the patentees is worthless and requesting permission to use foreign steel.

By this date, the patent had been transferred to Sir Basil Brooke, who was one of the farmers of the King's ironworks in the Forest of Dean, and a man of considerable influence. At any rate, the Privy Council turned a deaf ear to the users of steel, but more powerful opposition soon arose. Under a treaty between England and the Low Countries, there was to be free importation of commodities on both sides. The prohibition of the importation of steel struck a blow at the trade of the Dutch merchants; their representatives in this country entered a protest and the patent was revoked. Sir Basil Brooke then petitioned for the grant of a patent for the manufacture of steel according to the invention, without the prohibition of importation.

In the meantime, Dr. Flood, who occupied a prominent position in London, had been working on his own account to upset Brooke's patent. He had made an offer to pay the King £5000 for permission to make steel and had caused to be put in a number of certificates by artificers using steel to show the badness of Brooke's steel and the excellence of that made by the Frenchman Rochier. He now, May 30th, 1620, petitioned against the new grant to Brooke; he had brought over from foreign parts certain persons expert and skilful in the making of steel, intending to employ them in England, his good intentions are like to be frustrated by the new patent now sought for. The matter was considered in the Privy Council on September 27th, 1620, and we read in the Register under that date: "Whereas the business concerning the makinge of Steele within the Kingdome hath been of late often debated at the Board, and the patent formerly graunted to certaine persons for the sole makeing of steele and prohibiting the importation of anie from forraine parts recalled and taken in, as well in respect of the insufficiencie and badness of steele made by these patentees as for other reasons of state expressed in former orders of the Board. And forasmuch as Robert Fludd, Doctor of Phisick, hath at his great charge drawne over hither from forraine parts certain persons and amongst others one John Rochier a ffrenchman skillful and expert in makeing of steele and being an humble suitor for a patent to sett them on worke in that mystery for the good of the publicke did this day offer to the Board a certificate under the hands of manie Cutlers, Blacksmyths, Locksmyths, and other Artificers working in steele, that the steele made by the said Rochier is very serviceable, good and sufficient. And Doctor Fludd further undertakinge to make as good Steele as anie is made in forraine parts and to vent the same at easier and cheaper rates, than the outlandish Steele. That they will waste noe wood but only make it of Pitt Coale. That they desire no Barr of importation more than what the goodnes and cheapnes of their stuff shall occasion, and thirdly that his Ma^tie^ shall have a third part of the profitt arysing thereby."

King James was present at this meeting of the Council, and no doubt the offer of a third of the profits appealed to him. At any rate, it was decided to grant a patent to Fludd and Rochier "upon security to be first given as well for the makeing of good and serviciable steele as for conferring the third part of the profitt to his Ma^tie^."

The patentees seem to have got to work and to have produced steel, but whether there were any profits to divide is doubtful. Rochier died five years later. His widow alleged that he died of grief at being defrauded of the third part of the benefit of his patent by Dr. Fludd and Caleb Rawlins.[12] With the death of Rochier the project probably came to an end. It is somewhat remarkable that it should have come to us from France, for at this period it would seem that French steel was no better than our own.

In Piedmont, according to a work published fifty years later,[13] steel was made by taking small pieces of iron and powdered charcoal, placing the iron and the charcoal in layers in a large crucible on the top of which a cover was luted, and then inserting the crucible in a furnace. It is possible that this process may have been in use long before, and it may have been that which Rochier brought to England. It will be observed that he professed to use pit coal as fuel. The account does not state whether the iron was fused or not. If it was fused, the process was similar to that used for the production of Wootz steel; if not, it was the cementation process.

The idea that Dr. Fludd's undertaking came to an end with the death of Rochier is confirmed by the fact that he did not oppose the grant of a patent in 1626 to Richard, Lord Dacre, Thomas Letsome and Nicholas Page of a privilege for making steel by the way invented and perfected by Letsome at the charge of Lord Dacre and with the assistance of Page. Thomas Letsome was a merchant tailor of London. Richard Lennard, Lord Dacre of the South, was the owner of ironworks in Sussex, where possibly the invention was worked; he died in 1630, leaving a son, a minor. It is probable that the project was then abandoned.

While we have no express contemporary record of the fact, it seems to be the case that Sir Basil Brooke took the invention of Ellyott and Meysey down to Gloucestershire and started the production of steel by cementation at his ironworks in the Forest of Dean, and that it was from there that it spread to other parts of the country. In 1635, when the grant of a new lease for the Forest of Dean works was under consideration, he put forward the claim that he had settled the new invention of making steel in this Kingdom.[14] Certainly his name became well known in connection with this product. Fuller, in his "Worthies," in dealing with Gloucestershire, in 1662, fifteen or sixteen years after Brooke's death, refers to him as "the great steelemaker in this county,"[15] and, at about the same date, he is mentioned as a steel maker in proceedings before the Privy Council relating to another patent for steel. In 1693, as we shall see later, steel was still being made in Gloucestershire.

We come now to the first of our notes dealing with the production of steel in Yorkshire.

During the Commonwealth, Charles Tucker or Tooker of Rotherham, upon the allegation that he and one Morostey had doscovered a new process of manufacture, obtained from Cromwell a patent for the sole making of steel within the Kingdom. In 1662, soon after the Restoration, the "cutlers, sythsmiths, and many of ye artificers of hard wares in Halomeshire in ye county of York" petitioned against the grant of a new patent to him. They stated that Tucker's only object was to monopolise the making of steel, and so to compel the users to buy steel of him and at his own price; moreover, he had already acquired a great estate by the former patent. Forty years before Sir Basil Brooke, Sir William Bowes and others had made as good if not better merchantable steel, and since the Restoration, George Harrison and George Arderon had done the same, and at far cheaper rates than Tucker.

It was decided by the Council that no patent be issued to Tucker, or, if a grant had already been made, that it become void.[16]

However, the monopoly was too valuable for Tucker to relinquish without a further effort. He persuaded Sir John Reresby and Sir Thomas Strickland to apply for a patent and agreed to pay them £100 a year for the use of it. This patent was granted in 1665 (No. 146), and at the beginning of the following year there came before the Council the petition "of the makers of steele, cutlers, scissermakers and others ye makers of edge tools in Hallamshire in the County of York," praying that the patent be made void and that no monopoly of making steel may be admitted.[17] They recite the facts as in the earlier petition, adding, however, that Tucker was an active officer in the late wars against His Majesty, and that he obtained his patent by the favour of Lambert. They point out that neither Reresby nor Strickland were experienced in the art, "or ever publiquely did exercise the same," and state: "That on the 14th and 15th of January last, the said Sir John Reresby did cause a Bayliff of the liberty to publish a Paper at two severall market Townes, wherein he declared tha late Letters Patent he had obtayned were procured in favour of the said Tooker, and that Tooker is to pay one hundred pounds per annum to Sir John Reresby for a Deputation for the sole making of steele in this kingdome."

The matter was referred to the Solicitor-General with instructions to hear both parties. What happened afterwards does not appear, probably when Reresby and Strickland understood all the facts of the case, they threw up the patent. Reresby was a prominent Royalist and High Sheriff of Yorkshire. George Harrison and George Arderon, referred to above, were probably making steel in or near Sheffield.

There is no hint as to the nature of Tucker's invention. The writer is inclined to think that he, or Morostey for him, had acquired a knowledge of the cementation process from the Forest of Dean works, and that he had no new invention, or, that if he had anything new, it was a mere matter of detail. If this view be correct, then we may take it that the introduction of the cementation process into Yorkshire took place about the year 1650.

Another inventor of this period, who must not be overlooked, is Prince Rupert. He had a method of converting into steel all manner of edge tools, &c., formed of soft iron, but we do not know what his method was, or whether it was applied in practice. Possibly it was merely a case-hardening process.

Before the year 1686, the cementation process had been established at Kingswinford in Staffordshire. Plot tells us that John Heydon at the Tile-house at Bromley in that parish converted bars of iron into steel, and that he used not English but Spanish or Swedish bars. Plot's description of the process, the earliest known to the writer, is interesting, although, as will be seen, it omits one essential feature—the material put into the "coffins" with the iron. Plot indeed recognised that it was incomplete, and that the process as described was simply one of annealing, and says that he suspects there was something else "besides what John Heydon was willing to impart." Heydon, he says, "has a round oven built of brick like a baker's at the top, having a grate in the bottom near the middle, about a foot and a half or two foot wide, where he lays the coal; on each side whereof, and at the end beyond it, he lays his iron enclosed in coffins made of Amblecot clay to keep it from melting; the coffins being proportion'd to the barrs of iron, which are broken into lengths of between 3 and 4, or 4 and 5 foot long, the longest being placed at the end of the oven, and the shortest on each side; each coffin containing about half a ton of iron. When the fuel is put to it, it is constantly tended day and night till the operation is perform'd, which, according to the goodness or badness of the coal, is done in a longer or a shorter time, sometimes in three days and three nights, other times in four, and sometimes not under a week's time, the critical minute in which the operation is finisht being the great secret of the art of making iron into steel, which being done, they cut it into narrower barrs about half an inch over, and then break it into short

pieces of an inch or two inches long, call'd gadds, whereby the buyers may see whether it be good or bad (for there may be both in the same bar) otherwise they care not to buy it."[18]

Steel, it will be noticed, was still being sold in "gadds," as it was in the time of Queen Elizabeth, but now the imported article was coming in in the form of small square bars 7ft. or 8ft. long as well. Plot's explanation of the reason why the metal was broken up into such short lengths is no doubt sound, but the origin of this plan must have been to enable the makers to see the fracture and thus to send out a satisfactory article. The writer is of opinion that it was not usual to make the gads quite so short as stated by Plot.

By the close of the seventeenth century, the English steel makers were turning out a better article than that recorded by Harrison in 1677. Moxon says that the steels that are in general use here in England are the English steel, the Swedish, the Spanish and the Venice steel, there is good and bad of each of these, but one may be better suited for a particular purpose than another. "The English steel," he says, "is made in several places in England, as in Yorkshire, Gloucestershire, Sussex, the Wild of Kent, &c. But the best is made about the Forest of Dean, it breaks fiery, with somewhat a coarse grain. But if it be well wrought, and proves sound, it makes good edge tools, files and punches. It will work well at the forge and take a good heat."[19]

These notes can hardly be concluded without a reference to steel making in the neighbourhood of Newcastle-upon-Tyne, and the introduction of shear steel. Sir Ambrose Crowley, who was an alderman and carried on an extensive business as an ironmanger in London, in 1682, established ironworks at Sunderland, employing workmen from Liége and elsewhere on the Continent. In 1690 he moved his works to Swalwell and Winlaton, near Newcastle. At his Winlaton works in 1698, he was making, among a great variety of smithwork, augers, edge-tools, and files. The writer is not aware of any evidence that Crowley was at that date producing the steel from which these articles were made. But if he was not producing steel there, he must have started doing so soon after. At any rate, in 1712, the lading of the ship Anne included "10 whole faggots of steel, 6 half faggots of steel, 10 Bundles of Rod Steel," and "20 whole bars of blistered steel" from the Swalwell works.[20]

It is worthy of notice that when Crowley moved to Swalwell, a factory had just been established at Shotley Bridge on the Derwent, eight miles away, for the manufacture of "hollow sword blades." This factory was manned by German workmen, mainly from Solingen, and it is presumed that steel was made on the spot, and at first from local ore. Now towards the end of 1702, this works was closed down; it remained closed for about a year only, but no doubt the men dispersed—we know that one of them returned to Germany. It may be that some of these men found employment close at hand with Crowley, and that this date marks the start of steel making at Swalwell.

However that may be, Crowley's venture is specially interesting in that the introduction of the manufacture of shear steel is ascribed to him. We appear to have been importing large quantities of "German steel," and Crowley, it is said, brought in German workmen conversant with its manufacture.[21] The date of this is not known, but it will be noted that faggots of steel formed part of the ships lading in 1712. Jars, who visited Newcastle in 1765, states that steel was sold in various forms: (*a*) as it leaves the cementation furnace (blister steel). (*b*) Blister steel forged under the hammer (common steel). This was the form in which the greater part of the product was sold; it was sent in large quantities to Sheffield, Birmingham and other places. (*c*) Shear steel formed by faggoting bars of blister steel. This Jars calls "acier d'Allemagne," and remarks that the process was the same as that used in Styria, *i.e.*, the process of faggoting and doubling, except that in Styria it was used not with cement steel but with natural or direct steel.[22]

At the date of Jars' visit there were a number of cementation furnaces in the neighbourhood of Newcastle. Swedish iron alone was used, many experiments had, he says, been made with English iron, but it had proved impossible to obtain steel of the same quality.

As we have seen, Swedish iron was in use in Staffordshire in 1686, but its application for steel making in this country goes further back than that; in 1631, certain Aldermen of London, at the request of the Privy Council, were investigating the quantity of steel that could be produced from Swedish iron.[23]

Jars does not mention the manufacture of shear steel at Sheffield, but a couple of years after his visit, *i.e.*, in 1767, the process was brought there by a man named Eltringham from the Newcastle district.[24]

The next great step in steel manufacture in England was the introduction of cast steel by Benjamin Huntsman, and this is a convenient point at which to leave the subject, as his work has been dealt with by Smiles in his "Industrial Biography," and later by Sir Robert Hadfield before the Iron and Steel Institute in 1894.

[1] The second edition of Holinshed, 1587, gives "twelve sheffes to the burden."

[2] Minister's Accounts, Bundle 445, No. 7185, quoted in the Victoria County History of Sussex.

[3] This account of the steel works is derived from the MSS. of Lord de l'Isle and Dudley of Penshurst. The writer has to thank Lord de l'Isle for permission to examine them.

[4] Acts of the Privy Council, Vol. 7, page 333.

[5] Rousse, "Beauties and Antiquities of Sussex," second edition, 1827, page 112, quoting a document in the possession of Sir Godfrey Webster, the then owner of the manor.

[6] Public Record Office, Patent Roll, 12 James I., Part I., No. 15.

[7] "Philosophical Transactions," No. 203, page 865.

[8] An Essay upon Various Arts by Theophilus, called also Rugerus, Priest and Monk. Ed. Robert Hendrie, 1847. Theophilus, after instructing us to temper steel files, goes on to deal with small files made from soft iron, "molli ferro"; he says anoint them with the grease of an old hog, and bind them round with small straps cut from the skin of the buck goat, and tie them with flaxen thread. Afterwards cover them one by one with beaten clay, and leave the handles bare. And when they are dry, place them in the fire, and blow strongly and the skin is burned; and quickly taking them from the clay, extinguish them equally in water, and, being taken out, you will dry them at the fire (Book iii., Cap. 19).

[9] Plot, R., "The Natural History of Staffordshire," 1686, page 372.

[10] Howes' "Stow's Annals," 1615. About a hundred years later Ephraim How, another Londoner, is said to make the best knife blades in England (Harris, "History of Kent," 1719, page 359). It is to be borne in mind that the centralisation or localisation of industries such as we have to-day is comparatively modern. At about the same date as Ephraim How was said to make the best knife blades in England, another writer was saying that Oxford had the reputation of making the best knives in England (Plot, R., "Oxfordshire," 1705), and later on in the century, in 1776 and 1779 respectively, we find such unlikely places as Salisbury and Woodstock, Oxfordshire, described as famous for steel work. At the latter place, highly ornamental scissors were made ("Diary" of Mrs. Philip Lybbe Powis, 1899).

[11] Public Record Office, Patent Roll, 14 James I., Part 13, No. 12.

[12] Hist. MSS. Commission, Coke MSS., i, 197; 1625, May 23rd. Notes of 2nd Audience at Whitehall.

[13] Felibien, A., "Des Principes de l'Architecture, etc.," 1776.

[14] State Papers Dom. Charles I.

[15] Possibly Fuller's observations express fairly the standard to which English steel had attained in Brooke's time. He states that it is "useful for the making of English knives, sythes, scissors, shears, etc., but fine edges cannot be made thereof, as lancets for letting of blood, incision knives, dissecting knives, razors, etc."

[16] Public Record Office. Registers of the Privy Council, 1662, April 23rd.

[17] Public Record Office. Registers of the Privy Council, 1666, February 13th.

[18] Plot, R., "The Natural History of Staffordshire," 1686, page 374.

[19] Moxon, "Mechanic Exercises," second edition, 1693, page 54.

[20] "The Victoria County History of Durham," Vol. II., page 283.

[21] "Manufactures in Metal" (Lardner's "Cabinet Cyclopædia"), 1831, Vol. I., page 233.

[22] Jars, "Voyages Metallurgiques," Vol. I.

[23] "Remembrancia," page 528.

[24] Jeans, J. S., "Steel," 1880, page 13.

A New Method of Improving Power Factor.

During the course of a discussion at Leeds on the late Dr. Kapp's paper on "The Improvement of Power Factor," Mr. T. F. Wall described a new device which he has invented for that purpose. The invention was described some months ago in our patent columns, but the additional information which Mr. Wall has kindly sent us will no doubt be of interest to many of our electrical readers. Briefly, Mr. Wall has devised a phase advancer in which electrical energy is stored during one part of the cycle in the form of chemical energy and during the remainder of the cycle it is released in the form of electrical energy. The principle involved is therefore the same as that of a secondary battery, which in effect acts under the above conditions as a condenser of very large capacity.

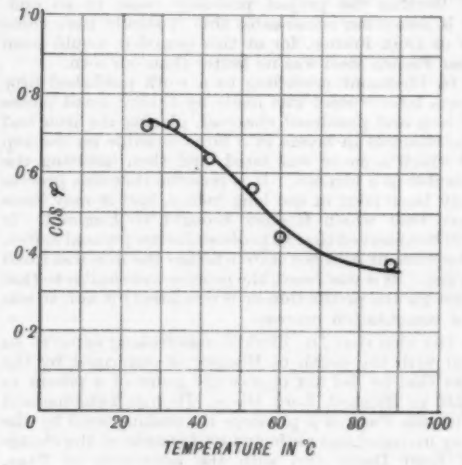


Fig. 1

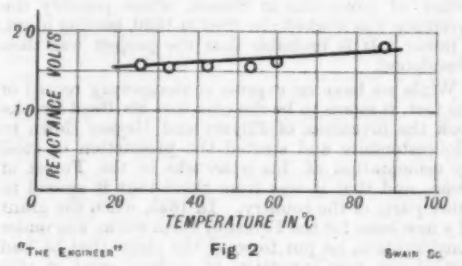


Fig. 2

Suppose that two lead grids, which may be designated A and B, are pasted with red lead (Pb_3O_4) and are immersed in dilute sulphuric acid and connected in circuit with an alternating-current supply. During one-half of the cycle the paste of one grid—say, A—becomes oxidised to the higher oxide, whilst that of the other grid is reduced to the lower oxide. In other words, the arrangement corresponds to an accumulator on charge, the grid A being the positive plate. During the next half of the cycle the action is reversed, and the cell is discharged and re-charged in the opposite direction. Experience has shown that the action is greatly assisted and improved if the cell works at a relatively higher temperature—say, at about 80 deg. Cent.—for when the temperature is increased to about this value the gassing is reduced to a negligible value. The losses are therefore low, whilst the phase advancing action is considerable.

In the curve Fig. 1 this effect is clearly shown, the values used in producing this curve being obtained by connecting a cell to a low-frequency supply whilst the cell was immersed in a bath capable of having its temperature regulated. A very considerable improvement of the action of the cell takes place up to about 70 deg. Cent., but subsequently the improvement is less marked with increase of temperature. The curve Fig. 2 shows the corresponding values of reactance volts which are plotted as a function of the temperature. The effect of increasing the temperature appears to be twofold, viz., to increase the specific resistance of the electrolyte and to stimulate the chemical activity of the components of the cell.

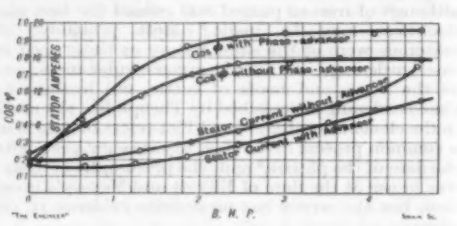


Fig. 3

As regards the second effect, it is of interest to note that the action of a certain lightning arrester is based upon the fact that the chemical stability of lead oxides is very easily upset by relatively small temperature rises. Dry lead peroxide (PbO_2) has a specific resistance of about 1 ohm per cubic inch, and the resistance varies with the pressure at which it is compressed. At a temperature of about 150 deg. Cent. lead peroxide is reduced to red lead (Pb_3O_4), which has a specific resistance of about 24×10^6 ohms per cubic inch, whilst at slightly higher temperatures red lead is reduced to litharge (PbO), which is practically an insulator. The results on a 4 horse-power motor fitted with a phase advancer of this type are given in Fig. 3, the tests having been made by two post-graduate students, Messrs. G. Allsop and G. E. Robinson. The tests were made with two cells in series per rotor phase, and they clearly show that beneficial results are to be obtained with a phase advancer of this type.

THE NEWCOMEN SOCIETY.

An exceptionally good meeting of the Newcomen Society for the Study of the History of Technology was held at the Iron and Steel Institute on Wednesday evening, when Mr. Rhys Jenkins presented a paper on "The Early History of Steel Making in England," which we reprint on page 572. Amongst the principal speakers were Sir Robert Hadfield, Mr. F. W. Harbord and Colonel Belaiew. It was pleasant to learn from the annual report presented by the secretary, Mr. Dickinson, of the South Kensington Science Museum, that the Society is in a good position financially, that its membership continues to increase steadily, and that the demand for the first volume of its "Transactions" is satisfactory. Mr. Arthur Titley, who has acted as President since the founding of the Society, surrendered his chair to Mr. Pendred, who, on taking it, said that he regarded himself as no more than a stop-gap for Mr. Rhys Jenkins, who was clearly indicated by his archæological attainments as the proper person to occupy the position of President. It was sincerely hoped that when Mr. Jenkins had completed the Life of James Watt on which he was engaged he would find time to accept the presidency. A well-attended dinner was held after the meeting in the Watt Room of the Engineers' Club.

Lantern Slides.—Brook, Hirst and Co., Limited, of Northgate Electrical Works, Chester, ask us to state that they have now a comparatively complete collection of lantern slides illustrating their "Safety First" motor starting panels, and that they will be pleased to lend to any intending lecturers the whole or any part of this collection, together with appropriate explanatory notes. They add that they are constantly adding to the slides and wherever possible they would be pleased to make additions to suit the needs of individual lecturers.

Standard Copper Alloy Pipe Fittings.—Report No. 99-1922, dealing with copper alloy pipe fittings for pipe sizes from ⅛in. to 4in., has just been issued by the British Engineering Standards Association. The report deals with the material to be employed, methods of testing and dimensions for equal and reducing sockets, elbows, tees, plugs, crosses, return bends, &c. Both "short turn" and "long sweep" fittings are included. The report contains numerous tables for equal fittings and the methods to be adopted for calculating the dimensions of reducing fittings, accompanied by explanatory figures in each case. Tables of centre to face dimensions for reducing fittings are given and also the standard sizes of these fittings in both short and long sweep varieties. Each type of fitting dealt with is illustrated by a figure. Some notes follow on the design of the fittings, accompanied by a diagram illustrating the method of setting out the curves for standard reducing fittings. The report concludes with appendices regarding screw threads and British standard test pieces. Copies of this specification, price 1s. 2d. post free, are obtainable from the offices of the B.E.S.A., 28, Victoria-street, London, S.W. 1.

A Seven-Day Journal.

Pilotless Aeroplanes.

A FORTNIGHT ago we noted a report from America announcing the success of tests made with a wirelessly controlled aeroplane with which the United States Army Air Service has recently been experimenting. Flights of over 90 miles were achieved, and it was claimed that the machine could be guided with great accuracy over any selected point and there caused to discharge its load of bombs. We pointed out that this performance had already been excelled by a French wirelessly controlled aeroplane in 1919, at about the time when the American experiments were being begun, and that the comparative ease with which the enemy might upset the control by "jambing" the wireless rendered the machine of very little value as a weapon of war. News is now to hand from France concerning a new form of pilotless aeroplane. Last Saturday, it seems, a demonstration was given at Etampes, on a Voisin 300 horse-power biplane, of the Percheron-Bernady system of aeroplane control. This system, as demonstrated, involves, it is understood, the use of gyroscopes and subsidiary engines. Ascent and descent and turning of the machine are controlled by the pilot, not by means of the usual wheel or stick, but by merely pressing one or other of a series of buttons. Presently it is intended to dispense with the pilot and effect the operation of the buttons pianola-wise by means of a perforated roll of paper and clockwork. Again the claim is advanced that the arrangement will add a new terror to bombing in warfare. In so far as the machine is independent of wireless control, it is free from the form of interference by the enemy, to which we have already referred; but unless automatic fighting apparatus can be added to it, it is hard to see how it could escape destruction at the hands of an alert enemy in the daytime, while at night the impossibility of observing it and correcting its course for errors in the estimation of the drift should render its chances of striking a selected target remote in the extreme.

The Duct Keel.

IN the Journal for September 15th mention was made of the duct keel system of ship construction as exemplified in the steamers Manchester Regiment and Nataliania. We understand that the two new Orient liners recently placed with Messrs. Vickers and John Brown are to be constructed with duct keels. In this system, it may be recalled, the main longitudinal member of the double bottom framing, instead of being a single vertical plate, is in the form of a box-shaped girder without internal cross stiffening. It thus provides a clear fore-and-aft passage within which the piping for the bilge and oil fuel systems may be accommodated. Its chief advantage is that all connections to the pipe systems may be made without requiring the piercing of water-tight bulkheads.

Forecasting Trade Cycles.

THE scheme for establishing a statistical forecasting service for industrial and business firms, which, as mentioned in the Journal last week, is now being worked out by the Economics Department of Cambridge University and the London School of Economics, has been brought to the attention of members of the Federation of British Industry in a circular letter issued from headquarters. The executive committee in charge of the establishment of the service is under the chairmanship of Sir William Beveridge, principal of the London School of Economics, and includes Dr. A. L. Bowley, Professor of Statistics, London University; Mr. J. M. Keynes, editor of the *Economic Journal*; and Mr. Charles Tennyson, assistant director of the Federation of British Industries. The secretary of the movement is Mr. E. L. Litton, of the London School of Economics, Clare Market, W.C. 2.

New Coal Loading Apparatus at Glasgow.

WHILE the South Wales and North-East Coast ports continue to experience great difficulty in shipping the coal coming forward from the mines, and are somewhat heatedly debating the question of introducing a third shift of tippers and trimmers, the authorities at Glasgow are carrying out experiments with a new form of apparatus for loading coal on board ships. The apparatus is the invention of Mr. D. Hopkins, mineral traffic superintendent to the Clyde Navigation Trustees, and was recently tested at the Rothesay Dock, Glasgow. It consists of an adjustable shoot, a turntable and a crane. The coal passes down the shoot from a hopper and is distributed within the hold of the vessel by moving the shoot outlet through the agency of the turntable. It is claimed that 80 per cent. of the coal can be loaded without calling for the assistance of trimmers, and that the remaining 20 per cent. can be trimmed by fewer men than the number at present required. The net result, it is said, is that the loading time can be halved. Moreover, it is claimed that the coal is loaded as received and is not assorted with the large coal outside and the small towards the centre, as is apt to occur with the common method of loading, the result being that the risk of fire, which generally starts among the small coal, is considerably reduced. Moreover, the avoidance of double handling of the bulk of the coal reduces breakage, while the clear passage into the hold does away with the necessity for cleaning the decks after the coal has been shipped.

The Government and Unemployment.

ALTHOUGH the Prime Minister is firmly adhering to his announced policy of refusing to receive deputations from the unemployed, the Government is very actively interesting itself in schemes aiming at the relief of the prevailing distress. It is quite evident that the Government intends to follow the principle of relieving unemployment by providing a stimulus to the carrying out of works of permanent public utility and will not fall back on any extension of the unproductive and demoralising system of distributing "doles." One interesting sign of the Government's activity in the matter was the summoning for Tuesday morning of a conference between Mr. Bonar Law and certain of his colleagues and the chairmen and general managers of all the important railway companies, with a view to discussing the possibility of the companies undertaking forthwith development works that would provide a considerable volume of work directly and indirectly. The railways are, of course, now free from Government control, so far at least that the Government is not in a position to dictate to them what works shall be carried out. At the same time, as is well known, certain of them have in preparation or ready schemes of development, such as electrification of large portions of their lines, for the beginning of which a favourable moment is being awaited. The Government apparently intends to use its influence and to provide what further assistance it can to get the schemes translated into actual work at the earliest possible moment. The representatives of the railway companies at the conference expressed their desire to assist in every way possible.

The Forth and Clyde Ship Canal.

THERE is probably no keener advocate of the rights of the ex-Service man, nor one more earnestly interested in the relief of unemployment than General Sir Ian Hamilton. We were therefore interested to notice that, speaking at Nelson, Lancashire, last Saturday afternoon, he added the weight of his influence to the proposal that, as a means of relieving unemployment, the Government should lend its assistance to facilitate the construction of the long-talked-of Forth and Clyde Ship Canal. Few people will to-day fail to agree with Sir Ian that the canal would be a work of Imperial importance, for it would not only assist commerce, but would add greatly to the efficiency of the Navy—that quality on which, now that its size is limited, our supremacy at sea must depend. The cost of the canal is estimated at about 24 million pounds, and its construction, it is believed, would give employment to some 50,000 men for about five years. Here, then, is an admirable work of public utility, which the Government might consider in its search for schemes to provide employment on a profitable basis. It is obvious, however, that Sir Ian would be well advised before further urging the merits of the scheme to study the geology of that portion of his native country through which the canal would run and to investigate modern methods of canal construction. Ex-Service men "with years of training in digging trenches" will experience, we think, some disappointment if they are led to believe from Sir Ian's remarks that for the construction of the canal they are "exactly what is wanted."

Temperature and Speed as Causes of Accidents.

REPORT No. 19 of the Industrial Fatigue Research Board, published to-day, presents two contributions to the study of accident causation, namely, the results of an investigation of the influence of temperature on the frequency of industrial accidents by Miss Osborne and Dr. Vernon, and of the relation between fatigue and speed of working, by Mr. Muscio. The temperature effect was studied in three munition factories. It was found that the combined results indicated a minimum accident rate when the atmospheric temperature was 67 deg. Fah., both for men and for women, and that as the temperature fell the accident rate for both rose very markedly, until at 52 deg. it was 35 per cent. greater than at 67 deg. At temperatures above 67 deg. the rate for women rose only slightly, whereas for men a 10 deg. rise produced a 60 per cent. increase in the number of accidents. In Mr. Muscio's contribution facts are adduced to show that the principal factor in the hourly variations in the number of industrial accidents is not fatigue, but the rate of working. This conclusion, it is remarked, seems to be true at least for the morning hours, although it may not be correct for other periods of the day. A detailed study of both sections of the report leaves us a little unconvinced that the results arrived at are of any great general value. They were obtained over too short a period or by means of experimental apparatus bearing too little relationship to actual workshop machines or tools to make their general acceptance justifiable without considerable qualification.

A New Electric Steel Making Process.

WHAT is claimed to be a plant using a new process of making steel electrically has just been installed by the Stobie Steel Company, of Dunston-on-Tyne, at the Sheffield works of Edgar Allen and Co., Limited. The plant consists of one 10-ton and one 3½-ton Stobie electric steel melting furnace, which are worked together as one unit. In the large furnace scrap steel is electrically melted and refined in a continuous manner. At short intervals a third or more of the bath is transferred down a shoot into the smaller furnace for finishing. From the electrical point of view it is claimed that the continuous working of the plant greatly increases the load factor, while the power factor is much improved by the maintenance of, mainly, molten baths. The fluctuations of the current are, in addition, reduced in amount and duration. Metallurgically the advantages claimed include the fact that frequent supplies of small quantities of steel, of varying composition, if desired, can be obtained for the same running cost as that involved in the operation of a plant of large capacity, a feature of importance for ingot or foundry work. In addition, as compared with an installation of several independent furnaces, the new plant, it is urged, economises floor space, reduces the crane service required, lowers the cost of repairs to the furnace linings, and permits of a freer choice of scrap for melting. It is understood that the guaranteed output of the Sheffield plant is 200 tons per week.

Stainless Steel Tubes.

IT is of very great interest to note that Messrs. Firth, of Sheffield, have, after a lengthy series of experiments, succeeded in manufacturing stainless steel tubing. So far, we believe, the tubes which have been produced do not exceed 15ft. in length and are about 3in. in diameter; but even so, the fact that stainless steel tubing can now be manufactured should be carefully noted by engineers and particularly by makers of condensers and similar appliances. Stainless steel is admittedly expensive, and on the score of its cost its use has been restricted to a greater extent than by any other factor. We would be prepared to find that in the case of stainless steel tubing the influence of cost would be still more restrictive. On this head, however, it seems to be hinted that it has been found possible, not only to produce stainless tubing, but also to produce it in a manner new to tube making in general, involving fewer processes and a greatly reduced manufacturing cost.

Enforcing Trade Agreements.

THE Boot Manufacturers' Federation and the National Union of Boot and Shoe Operatives have made an agreement with each other to endeavour to secure the passing of an Act of Parliament under which national industrial agreements will be accorded a legal standing and will be enforceable by law on federated and non-federated employers and on union and non-union workers in the trades concerned in the agreement. This agreement clearly involves a very important principle of general interest to all employers of labour, and if it reaches the stage of becoming a parliamentary Bill may be expected to arouse a considerable amount of discussion. In the present instance the initiative came from the employers. Eighty-five per cent. of the boot manufacturers are in the Federation, and in the past considerable difficulty has been experience in enforcing agreements reached between the Federation and the union upon the remaining 15 per cent. non-federated firms, so much so that the latter are held to constitute a menace to agreements in the trade. As indicating the federated employers' attitude to the non-federated firms, we may recall that some few months ago the Federation came to the assistance financially and otherwise of the workers at the non-federated establishments in a dispute with the employers. During the recent election the Federation approached some 500 candidates for Parliament to determine whether they were in favour of an Act making trade agreements enforceable by law. It is stated that two-thirds of the candidates answered unconditionally in the affirmative and that only two absolutely negative replies were received.

The Vaal River Scheme and Barrage.*

By W. INGHAM, M. Inst. C.E., M.I. Mech. E., Chief Engineer, Rand Water Board.

THE Vaal River scheme, which is now nearing completion, was authorised by the Union Parliament in June, 1914, but owing to the outbreak of the war the construction of the Barrage was not commenced until October, 1916. From November, 1917, to March, 1919, a period of seventeen months, it was, however, impossible to carry out any work in the river bed owing to the very high flood discharge of the Vaal River. The works were also delayed during and subsequent to the war owing to a number of causes which it is not necessary to enumerate here.

IMPOUNDING RESERVOIR.

The Vaal, like many South African rivers, carries, during flood periods, very large quantities of silt, and to obviate the danger of the reservoir being silted up the structure chosen to dam up the water is of the barrage type, and consists of a series of large sluice gates, which can be opened to pass all floods. This design prevents the accumulation of silt in the reservoir area, and also avoids the flooding of private property on the river banks. The quantity of silt carried down the Vaal River at the Barrage during an average year is 16,000,000 cubic feet, or 1,200,000 tons, and this would cover 720 acres to a depth of 6ft.

The flow of the Vaal River has varied between no flow in October, 1912, to 187,000 cubic feet per second—about 101,000,000,000 gallons per day—on November 22nd, 1917. The silt contents has been found to vary between 80 parts per million in winter to about 1050 parts per million in summer when the river is in flood, but it is probable that the latter figure may occasionally rise to 1500 parts per million by weight.

The depth of water held up at the Barrage is 25ft. 1in., and this backs up the Vaal River for a distance of nearly 40 miles. The maximum width at full supply level will be about 4000ft., and the top water line is 120 miles in length. The reservoir, when full, will have a capacity of 13,633,000,000 gallons, and, after allowing for losses due to evaporation, absorption and water contained in the reservoir below the point of abstraction by the pumps, and deducting the 1800 million gallons reserved for riparian owners on the reservoir area, there will be 20 million gallons per day, or 7300 million gallons per annum available for the water supply of the Rand.

THE BARRAGE.

The Barrage has been constructed about 25 miles down-stream of the Vereeniging railway bridge, and the point of abstraction is about 1½ miles below the railway bridge, where the river pumping station has been constructed. The original width of the river at the Barrage site was 620ft., but the length of the Barrage is 1400ft.—Fig. 1. The object of cutting into the banks of the river was to increase the waterway to compensate for the area taken up by the concrete piers and additional gate area in case of injury to the gates, so that no question could arise in future in regard to the obstruction of the natural flow of the river during high floods. The additional waterway is approximately 40 per cent. greater than the largest flood area. The rock at the Barrage site was continuous for the whole width of the river, and no difficulties were encountered in obtaining a good foundation, see the illustration at the left top corner of our two-page Supplement.

At the Barrage site alone 275,000 cubic yards of rock, loose shale clay and earth have been excavated.

Hydraulicing was adopted for removing the clay and earth on the Orange Free State bank. The plant installed for this work included a Sulzer centrifugal pump capable of raising 2100 gallons per minute against a head of 80 lb. per square inch. A 250 horse-power steam engine was installed for driving the pump by means of a Renolds chain. The delivery pipe from the pump was 15in. diameter and had three 8in. branches. Three "Monitors" were used for removing the material, and the nozzles were 1¼in. and 1½in. diameter. This method was found to be very cheap and expeditious for removing earth and soft clay, but hard clay had to be excavated with pick and shovel.

A concrete apron covers the river bed for the entire length of the Barrage and for a width of 100ft. down-stream. This apron is necessary to prevent erosion of the foundations, and is carried for a distance of 45ft. down-stream of the piers—see the illustration at the right top corner in our Supplement. The velocity of the water, with a full reservoir, when a gate is raised 12in., is about 38ft. per second. The average thickness of the apron is 4ft., and the concrete mixture is 6 : 3 : 1, except for the top 6in., which is 5 : 2½ : 1. Longitudinal and cross drains were constructed under the apron, down-stream of the gates, to prevent any possibility of fracture due to upward pressure.

On the down-stream edge of the apron a dwarf wall, 3ft. high, has been constructed to form a water cushion at the back of the gates, so as to break the velocity of the water when the gates are being opened—see Supplement. Cross walls have also been built at every fourth pier to prevent cross currents.

The Barrage consists of a series of piers with large mild steel sluice gates erected between the piers. There are thirty-five piers and two abutments, thus giving thirty-six openings, which are closed by thirty-six gates. Each pier is 8ft. thick, 34ft. 6in. high, and 55ft. long, and the foundations for the piers were carried down into the solid rock below the apron foundation—Fig. 2. The concrete mixture for the piers was 5 : 2½ : 1. The average depth of the pier foundations was about 6ft. below the surface of the rock, and the concrete is strengthened by heavy steel rails to prevent damage in case a gate should run down quickly at any time. The gear for operating the gates is placed on a platform 35ft. above the top of the piers, and the platform is supported by a series of reinforced concrete columns 2ft. 6in. square, well braced together by cross members—see Supplement. The platform, main and secondary beams are all made of reinforced concrete.

The whole of the concrete at the Barrage has been made by the Duff-Abrams method, which is dealt with fully in a paper presented by the Resident Engineer, Mr. J. C. Hawkins, to the South African Society of Civil Engineers. The paper referred to is "Concrete Making on Modern Lines," and appears in Vol. 19, Session 1921, of that Society.

GATES AND OPERATION.

The steel sluice gates closing the openings are 25ft. high and 32ft. 6in. in width, closing a 30ft. opening between the piers—Fig. 4—the gates are let into a slot in the side of the piers for a distance of 18in. In these slots are placed the vertical roller trains on which the gates slide, and the rollers run on cast iron machined liners, which are bolted securely to the concrete of the piers. Each gate weighs about 26 tons, and to enable the lifting and lowering to be carried out easily the gate is balanced by a counter-weight of about 60 tons, as the counterweight only travels through half the distance that the gate travels. The gate is attached to the counterweight by means of two $1^{7}/_{16}$in. diameter flexible galvanised wire ropes; each rope passes over and around a double conical grooved drum, then over a pulley attached to each end of the counterweight, and the free end is attached to an adjustable capstan erected on the top platform—Fig. 3. The conical drum was designed to overcome certain difficulties of operation; for instance, when the gate is closed the rope attached to the gate lies on the small diameter of the cone, while the end of the rope from the counterbalance lies on the large diameter of the cone, so that when a gate is being opened the counterbalance acts on a greater leverage than the balancing leverage of the gate, and consequently the greatest force is exerted at the start. Immediately movement commences the diameter of the cone on the counter-balance side decreases, while that for the gate increases until about halfway through the full travel of the gate, when the ropes lie on equal diameters; after this point the cone diameter for the gate is greater than that for the conterbalance, and thus an adequate braking effect is introduced which brings the gate to rest.

It must be remembered that the total moving loads are about 82 tons, and as the gate travels through a distance of 23ft. in about one and a-half minutes the forces brought into play are very considerable. In addition to the automatic braking, a fly-wheel 33in. diameter and weighing 400 lb. is connected through the operating gear and acts as a damper in preventing excessive speeds from being built up during the earlier portion of the travel. The two drums for each gate are connected by a 3½in. diameter steel shaft, with the operating headstock placed in the middle of the shaft. When a gate is to be raised a clutch is withdrawn, and this frees the gear; the counterblance then raises the gate to a predetermined height, and this point has been fixed at 21ft. above the sill of the gate with a full reservoir. To close a gate the clutch is replaced and the gate is lowered by hand through worm gearing. This operation will take two men about twenty minutes, so the whole of the gates can be closed in about twelve hours.

Provision has been made to raise the gates about 7ft. 4in. above the highest known flood level, which was about 26½ft. deep in November, 1917.

Up-stream of the slots in the piers which house the ends of the main gates a further set of slots is provided for inserting a spare gate to close the opening should it be necessary at any time to remove the main gate for repairs, and two spare gates are available for this purpose. One of the spare gates is shown in position in Fig. 3. In order to remove the spare gate easily a valve has been fixed in the gate so that water can be allowed into the space between the gates.

A railway track has been laid along the whole length of the Barrage, on which a Goliath crane, driven by a petrol engine, travels for transporting the gates. The track is carried from pier to pier on reinforced concrete girders which are 10ft. apart—see Supplement. The whole of the excavation and concrete work was carried out departmentally, but the gates were made by Messrs. Glenfield and Kennedy, of Kilmarnock, to the design of the Chief Engineer of the Board, and the contract price or the supply and erection of the gates is £162,000. Messrs. Blane and Co. are the local agents for the makers of the gates.

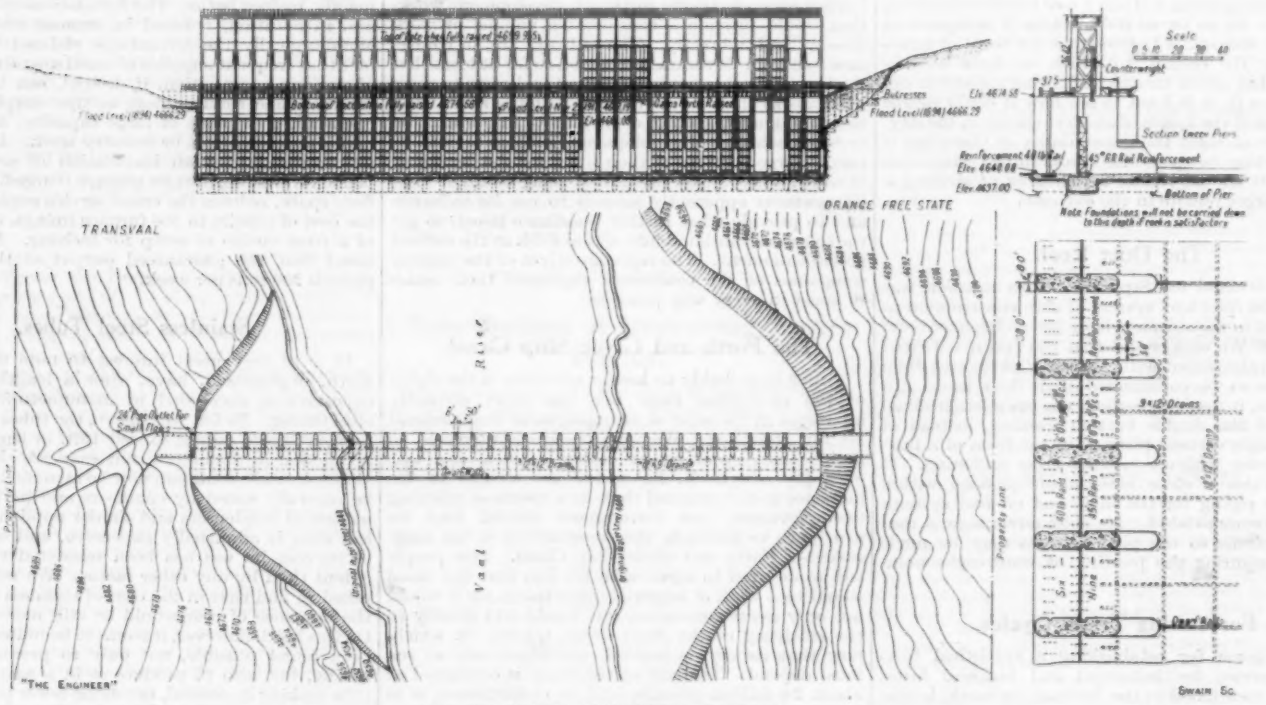


FIG 1—THE VAAL RIVER BARRAGE

PUMPING PLANT.

The water is abstracted at Vereeniging at a point 23½ miles up-stream of the Barrage, where the river intake station has been built. The building is of reinforced concrete, 47ft. long by 30ft. wide, and the motor floor is 55ft. above the river bed level. The substructure is divided into eight compartments for installing four electrically driven vertical spindle pumping units. The pumps are installed in dry chambers, and a set of screens will be erected in the wet chambers nearest to the river. The compartment nearest the river has a 3ft. by 2ft. 6in. opening, controlled by a specially designed penstock. Iron screens with ¾in. spacings are fixed over the outer openings, and two sets of fine brass wire screens in the wet chambers. The pumps will draw the water from the front chamber by means of pipes placed in the dividing wall, so that the pump chamber will always remain dry. This enables the pump and shafting to be examined and repaired without difficulty. Electric motors will be installed on the top floor for driving the pumps, and electric current will be generated at the main station, about 1 mile away, and transmitted through an underground cable. Each unit installed at the river pumping station will be capable of raising six million gallons per day against a head of 86ft. to the sedimentation tanks at the main pumping station.

The pumps are made by Amag-Hilpert, of Nürnberg, and the motors by Siemens-Schuckert, of Berlin. This station is arranged to be run automatically from the main station; that is to say, the motors can be started up and

* Paper read before the South African Institution of Engineers, September 13th, 1922.

shut down and also the speed controlled, electrically, from the switchboard at the main station. Special protective devices will be installed to ensure that, should the plant at the river station shut down owing to the switch tripping as the result of any defect developing in the plant, it cannot be re-started from the main station until the plant has been inspected and the apparatus re-set at the river station. The pumps are specially designed to deal with Vaal River water, which may on occasions carry as much as 1500 parts per million of silt and other suspended matter. The motors are each 185-kilowatt, 2000-volt, 50-cycle, three-phase asynchronous type.

A 10-ton hand-operated crane is being installed in the river station for handling the machinery. The water from this station is pumped to the main station through a 33in. diameter pipe line, and the length of the pipe line is about 5500ft., one half of which is Hume pipe and the other half steel riveted pipe.

MAIN PUMPING STATION.

The water from the river intake station, before being delivered into the sedimentation tanks, is treated with sulphate of alumina, and the water is then run along a trough arranged with baffles, so that thorough mixing takes place. The water then enters the sedimentation basins, four of which have been constructed to deal with a total of six million gallons per day. The sedimentation tanks are 225ft. long, 75ft. wide, and have an average depth of about 8ft., the capacity of each tank being 800,000 gallons.

The slow passage of the water through these tanks enables the flocculent precipitate, caused by the sulphate of alumina, to settle to the bottom, and to carry down with it the greater portion of the suspended matter and bacteria. It is anticipated that over 80 per cent. of the bacteria will be removed in the tanks by adding from 1½ to 3 grains of sulphate of alumina per gallon of water. When the water leaves the sedimentation tanks it is passed through a set of eight Paterson filters, and the clear water from these filters is collected in a small reservoir situated in the basement under the central portion of the filter-house.

FILTER-HOUSE AND PLANT.

The filter plant is of the gravity rapid type, and the water is passed through a bed of sand and gravel and collected by means of a pipe network known as manifold. The finely divided flocculent precipitate which does not settle in the sedimentation tanks is retained on the sand bed. After a certain length of time, the duration of which is determined by the quantity of silt in the water, the efficiency of the sand bed becomes impaired and it is necessary to wash the sand. This is effected by shutting off the raw water, draining off the water above the sand and then blowing back, through the manifold, a large volume of compressed air and water. Immediately after the air is shut off, water under a head of 30ft. is discharged through the manifold and upwards through the sand bed; this washes all the particles of sand, and the dirty water is run to waste into the sump below the filters. After a short time has elapsed the wash water is shut off and the filter is started again; the pipe arrangement is such that the first discharge from the filters after washing can be run to waste, and as soon as the water is clear it will be turned into the collecting reservoir. The whole of the filtration plant, in addition to the chemical feed apparatus, is being supplied by the Paterson Filtration Company, through the local agents, Messrs. Blane and Co. The outlet from the filters is controlled by a float valve which automatically restricts the flow through the filter if the quantity is greater than a certain predetermined figure.

The chemical feed apparatus is for the purpose of introducing sulphate of alumina and lime into the raw water before it reaches the sedimentation tanks. The apparatus is controlled from a Venturi tube inserted in the pipe line, so that any difference in flow automatically affects the apparatus and discharges more chemical if the quantity of water increases, or restricts the quantity of chemical if the quantity of water decreases.

Two sets of centrifugal pumps are installed in the filter-house; these pumps raise the water from the collecting reservoir in the basement to a clear water reservoir having a capacity of five million gallons. The pipe line to the large reservoir is 24in. diameter, and a by-pass is arranged so that all or any portion of the water can be diverted through the condensers in the main engine-house and thence to the large reservoir. After the clean water leaves the condensers it will be sterilised with chlorine if found necessary.

BOILER-HOUSE AND PLANT.

Three Babcock and Wilcox boilers are being installed for the five million gallon scheme, and each boiler is capable of evaporating 8000 lb. of water per hour at a pressure of 200 lb. per square inch and superheated to a total temperature of 600 deg. Fah. The boilers are fitted with chain grate stokers, and at the back of the boiler-house elevated reinforced concrete coal bunkers are being erected. An underground bunker will be constructed below the railway line, and elevators will be installed to raise the coal from the lower to the elevated bunkers, so it will be observed that the coal will be handled mechanically after it reaches the station. The chimney will be 45ft. high, and two Sirocco fan blowers, 55in. diameter, are being installed, one run by an electric motor and the other by a steam engine of 55 horse-power; either fan is capable of dealing with the whole of the flue gases from the three boilers, plus 50 per cent. for future extension.

ENGINE-HOUSE AND PLANT.

The engine-house adjoins the boiler-house, and the following plant will be installed:—

Electrical Plant.—Two sets of Allen-Metropolitan-Vickers turbo-driven alternators. The Allen steam turbines run at 5000 revolutions per minute and are geared down to 750 revolutions per minute through double helical gearing to suit the alternators, which are made by the Metropolitan-Vickers Company.

The voltage is 2200 and the current three-phase, with a normal periodicity of 50 cycles per second. The full-load rating of each alternator is 350 kilowatts at a power factor of 0.8. The switchboard and all switchgear is also made by the Metropolitan-Vickers Company.

The principal pumping units driven by the electrical plant are the river intake pumps and the filtered water pumps, the quantity of water raised in each case being approximately the same. To vary the quantity of water delivered by these pumps the alternators have been designed to operate on periodicities varying between 45 and 55 cycles as required.

By raising the frequency all the motors are speeded up and the output of the centrifugal pumps to which they are connected is increased in a fixed ratio. By lowering the frequency the output is reduced. The design is such that at normal full load the frequency will be 50 cycles per second. In order to provide for the different characteristics of the river and filtered water pumps the motors for these pumps are also fitted with a hand-regulated speed control with a range of 18 per cent.; this will enable each unit to operate at its maximum efficiency.

One condenser, common to both generators, is being installed, but there are two air pumps, one steam driven and the other electrically driven.

Pumping Plant.—Two sets of "Allen" turbo-driven centrifugal pumps are being installed. The steam turbines run at 4700 revolutions per minute and are geared down through double helical gearing to the speed of the pumps, which run at 900 revolutions per minute.

The pumps are four-stage centrifugals and the normal quantity raised is 5.5 million gallons per day against a head of 510ft. In this case each turbine has its own condenser, and there are two air pumps, either of which is capable of dealing with the total duty of the two condensers.

ZWARTKOPJES PUMPING STATION.

The water from Vereeniging is pumped to the Zwartkopjes station, where the whole of the water is re-pumped to the Rand. The plant at this station consists of four Hathorn-Davey inverted vertical direct-acting steam pumps, each capable of pumping 2.4 million gallons per day against a head of 960ft. One turbo-driven centrifugal pump capable of delivering 5½ million gallons per day against a head of 1150ft. The turbine was made by Parsons, of Newcastle-on-Tyne, and the pump is a Sulzer four-stage centrifugal, made at Winterthur, Switzerland. Another pumping set of the same capacity as that just described will be installed within the next few months. This set will be a Zoelly steam turbine driving a Sulzer centrifugal pump.

The electrical plant installed at the station is as follows:

Four Belliss and Morcom high-speed enclosed steam engines direct coupled to 3000-volt, three-phase, 25-cycle 460 kilovolt-ampère Westinghouse generators.

One Belliss and Morcom exhaust steam turbo-generator of 720 kilovolt-ampère capacity.

The electrical sets generate current for driving the bore-hole pumps at Zwartkopjes and also for driving the centrifugal pumps at the Zuurbekom pumping station, about 17½ miles away.

RESERVOIRS.

The following service reservoirs have been constructed in connection with the new scheme:—

	Contents in million gallons.
On hill north of Benoni	2
On Signal Hill, Germiston	2½
At Forrest Hill, Johannesburg	5
At Zwartkopjes	5
At Vereeniging main station	5
Total, million gallons	20

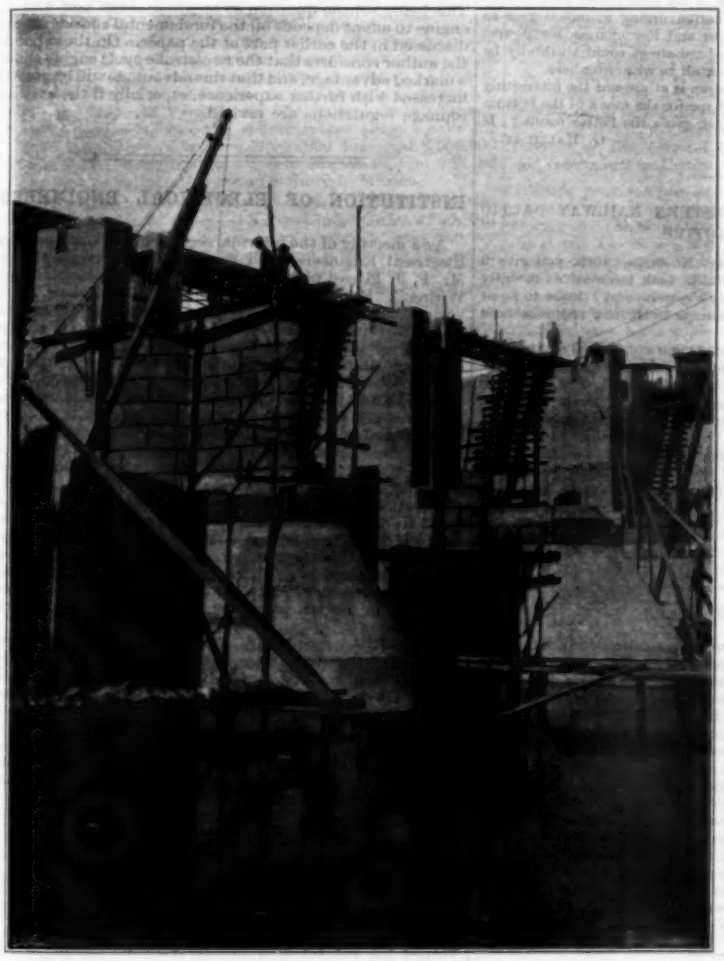
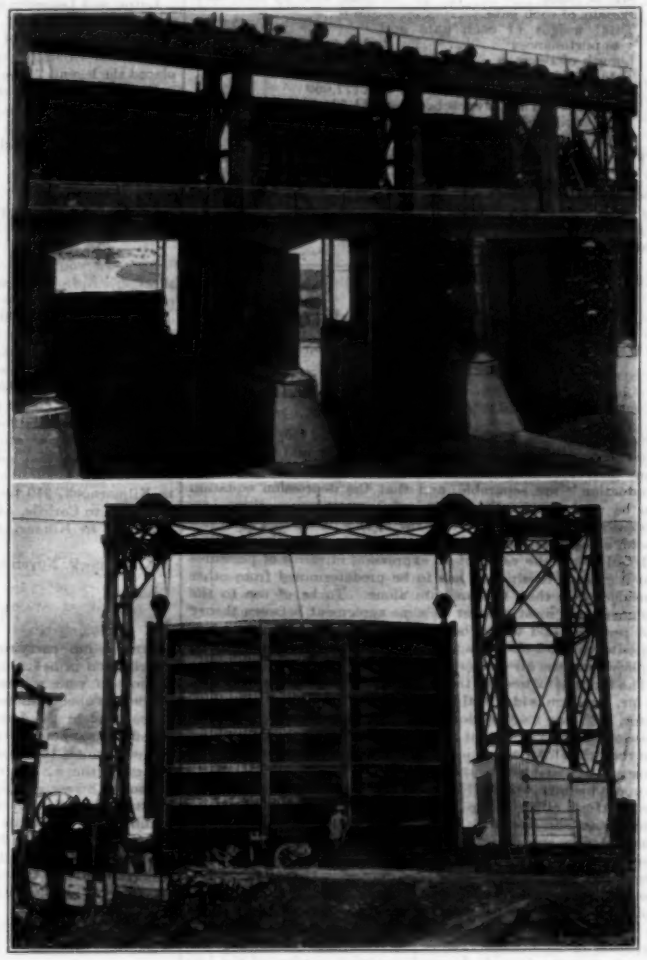


FIG. 2—VIEW SHOWING PIERS BUILT TO FULL HEIGHT AT ROAD BRIDGE LEVEL



FIGS. 3 AND 4—SLUICE GATES

PIPE LINES.

The following pipe lines have been laid in connection with the new scheme :—

Location.	Dia. of pipe. Inches.	Lineal feet.
From Benoni to Benoni Reservoir	12 ..	12,500
From Simmer and Jack to Signal Hill Reservoir	12 ..	4,000
From Village Main Reef to Signal Hill Reservoir	24 & 27 ..	35,500
From river intake to main station, Vereeniging	33 ..	5,500
Main station, Vereeniging, to Zwartkopjes	22 & 24 ..	140,000
Zwartkopjes to Leeuwpoort ..	18, 21 & 24 ..	89,000
Lineal feet		286,500

or a total length of nearly 54 miles. The total weight of the pipes is 11,500 tons of 2000 lb.

The total cost of the scheme as described is £1,525,000, and it will be completed in April, 1923.

The principal particulars of the Barrage are as follows :—

Excavation	275,000 cubic yards
Stone crushed for concrete	42,200 cubic yards
Sand	20,400 cubic yards
Concrete	41,000 cubic yards
Cement	10,000 tons
Materials transported to the Barrage from Vereeniging	20,000 tons
Length of reservoir	40 miles
Contents	13,633,000,000 gallons
Number of gates	36
Depth of water at Barrage	25ft. 1in.
Size of gates	30ft. wide by 25ft. deep
Weight of each gate	26 tons
Total weight of each gate and appurtenances	100 tons
Length of Barrage	1400ft.
Total cost of Barrage	£450,000
Total cost of Barrage and bridge ..	£477,000
Total cost of Vaal River scheme ..	£1,525,000
Total capital of Rand Water Board when new scheme is completed ..	£5,000,000

The author wishes to acknowledge his indebtedness to Mr. C. E. Mason, the Board's principal electrical and mechanical assistant ; Mr. M. Udwin, chief civil engineering assistant ; and Mr. J. C. Hawkins, resident engineer at the Barrage, for their assistance in connection with the scheme.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

GASEOUS FLUID EJECTOR.

SIR,—There are a few points raised by Mr. Hepburn in his letter in your issue of November 17th that I should like to comment on very briefly. He maintains that "depression" and "induction" are separable, and that the depression equation can be used alone. Illustrative of its application, there is a numerical example worked out, the figures of which I shall not quote, as he says they are only to indicate the method ; but I still fail to see the value of an expression in terms of pressures which gives a result that has to be predetermined from other considerations than the pressure alone. To be of use to the designer there must at least be some agreement between theory and practice, and while there are always points of interest in opposite views, I do not agree that the theory of depression is applicable to the air ejector.

The formula expressing the mass ratio of air to steam as given by Mr. Hepburn is identical with that put forward in my previous letter, with two modifications. He has made the index of compression different from that of expansion, and it appears without the root sign. An alteration to the index of compression is, of course, necessary where water cooling is employed ; otherwise, to quote his own words, "In view of the extreme variability of the mixture ratio of the inductate," it appears artificial to attempt to eliminate one uncertainty by the introduction of another. The square root, however, has nothing to do with the compression index and its presence is easily explained. The two expressions have evidently been derived in the same manner, the one being the equation of energy and the other of velocity, and surely when one gas impinging on another imparts motion to the latter, the only treatment which is applicable is the conservation of momentum, hence the root sign. Regarding the remark that the formula is quasi-empirical in view of the low values of the correction factor (.75), how much more empirical must his formula be, which, to get the same results, introduces as a correction factor .48 × .9 ?

The test of the two-stage ejector which Mr. Hepburn witnessed appears to give figures in fairly close agreement with modern practice, and had more data been available it might have been interesting to analyse them.

The current advertisements, which state that the vacuum is unaffected by a given range in operating steam pressure, cannot be taken too seriously. In designing ejectors there is always a margin allowed for boiler fluctuations, but this does not necessarily mean that the fluctuation is shared by the ejector.

November 24th. INTERESTED.

TENONS OF RAILING BARS.

SIR,—There is a controversy going on up in Marylebone just now amongst mechanical engineers on the one side, and surveyors on the other, on the question of railings and how they should be made. The question is somewhat complicated by the question of the money available to do the job. To be quite accurate, there is not much money left for the job. The bricks of two old houses were available for filling in the building of brickwork under the railings, but someone, in a forgetful moment, sold the houses for a song and new bricks had to be bought for the work throughout, and the foundations were more expensive than was expected, and so very little was left for the railings. There was little latitude left for choosing a way to construct the railings, excepting that it had to be the cheapest way.

The bars were 1in. square, 5ft. in height, and tapered at the top. There were two rails. The bars went through square holes in the top one and were leaded in, while they were tenoned at the bottom and riveted in. With regard to the tenons at the bottom, the drawings left the question open whether they should be round or square, and there were no specifications. There is the Office of Works practice—in fact, I think, the almost universal practice—to make the tenons round and the holes round, the tenons being a driving fit into the round holes and then rivet them over.

Anyway, the cost of making the round tenons and the round holes comes out about one-sixth of the cost of the square tenons and the square holes, and it just suited this job, as there was so little money left to do the railings in any way.

Following the Office of Works practice—and one may always do this safely in any practical thing—estimates were sent in for making round tenons and round holes, and, after acceptance, the tools were made for machining them.

Surveyors are not as other men. After everything was settled they wanted a large shoulder at the tenon, and that, for the same size tenon, can only be obtained by making it square. That was the reason given.

Now, curiously, some 2000 years ago or more a very ancient people found that the relation of the shoulders of round tenons to the shoulders of the square tenons were as 100 to 78, or, roughly, the shoulders of the square tenon are to the shoulders of the round tenon as 3 is to 4. This was pointed out, as also that it was six times more expensive to make. Square tenons they had to be.

They are very modern here in Marylebone. Repetition and the great advantage of getting everything made at once and all of the same size so that they would simply fall into their places when carried to the job was adopted. The coping was all to be cut with holes for the stanchions all of equal distances apart. One set of holes was to the measurement on the drawing ; all the others were much different, and the top and bottom rails were different in each case. So that the repetition business fell to the ground.

Luton and Leicester and most of the near towns have attractive advertisements at every station urging manufacturers to come there because of low rates and low charges for power. At the Oxford-street end of Orchard-street could truthfully be placed the legend "Abandon hope all ye who enter here."

But the point with which I began is at present the interesting one to us. What is the better shape for the tenon of the bottom of the bar in a railing, and which gives the better result ? Is the Office of Works right ? G. HALLIDAY.

November 27th.

GLASGOW AND SOUTH-WESTERN RAILWAY BALTIC LOCOMOTIVE.

SIR,—In your issue of Friday, November 10th, you give a short description of the new Baltic tank locomotives recently put into service on this company's system, and I desire to point out to you an error which, in fairness to the new engine, should be corrected.

In the last paragraph on page 502 you say, "On a test trip the following train loads were handled," and you thereafter quote loads on the several sections of the line from Glasgow to Carlisle and *vice versa*. Please allow me to point out that the loads you have quoted are the loads permitted at present for one tender engine presently working over the several portions of this line, and that the actual loads of the "Baltic" type engine during the test were much in excess of your figures, namely :—Glasgow to Kilmarnock, 310 tons ; Kilmarnock to Dumfries, 340 tons ; Dumfries to Carlisle, 440 tons ; Carlisle to Dumfries, 440 tons ; Dumfries to Kilmarnock, 325 tons ; Kilmarnock to Glasgow, 300 tons. ROBT. H. WHITELEGG.

Kilmarnock, November 27th.

HELICAL GEARS.

SIR,—I am carrying out an investigation into the stress distribution in helical gears, and would feel very much obliged if those of your readers who have the information could send me details about failures in order that I may fix on the constant to be used in the formulæ. I would like to have details of construction about the pinions, especially their lengths, numbers of revolutions to fracture, and power or pressure on teeth. Inserting the *n*, the number of revolutions into the fatigue formula : Stress = fatigue limit plus $C(10^6/n)^{\frac{1}{3}}$. Where C is a constant, the local fracturing stress would be known. The number *n* need only be an approximate one. I understand that failures are fairly evenly distributed amongst the various manufacturers, and I hope that they too will not hesitate to send me what information they have, as names will not be mentioned.

C. E. STROMEYER, Chief Engineer,
Manchester Steam Users' Association.

Manchester, November 24th.

CHANNEL STEAMERS.

SIR,—Referring to your interesting articles on Channel steamers, may I point out that the Calais-Douvres, which you credit to the year 1893, was at work with the Empress and Victoria in time for the Paris Exhibition traffic in 1889. An account of her may be found in *The Times* for April 24th, 1889. These fine ships, with their large area of unobstructed promenade deck, were more comfortable in good weather than any of their successors.

And was not the Duchess of Devonshire, which you include in the Lancashire and Yorkshire fleet, a Barrow boat running in association with the Furness Railway Company ?

London, S.W. 1, November 25th. W. B. THOMPSON.

Four-Stroke and Two-Stroke Cycle Engines.

IN a paper read before the Liverpool Engineering Society on Wednesday evening last, Mr. A. S. Watkinson dealt with the relative advantages of the four-stroke and two-stroke cycle marine Diesel engine. The subject is not new, and it is one which, judging from recent articles in the technical Press, is apparently difficult to discuss without a certain vehemence of opinion which detracts from an impartial consideration of the merits and demerits of these two types of prime mover. The author finds that at the present time there are in this country five designs of four-stroke cycle engine manufactured by eight different firms, and six designs of two-stroke cycle engines which are manufactured by fourteen different firms. These eleven designs of engines, especially those of the two-stroke cycle type, differ very widely in design, thus making the choice of an engine a very difficult task for the shipowner. The object of the paper is to survey the subject from an impartial point of view and assign to each point raised its due importance. After a brief historical introduction the author proceeds in the first part of the paper to deal with fundamental considerations, such as weight, space occupied, fuel consumed, and the cost of the machinery, this section being accompanied by tables giving particulars of the leading makes of engine, comparison of weights and the saving effected in cargo space. Diagrams are given showing the machinery arrangement of the Peru with Burmeister and Wain engines running at 125 revolutions per minute, and the same engine-room if Camel-laird-Fullagar engines running at 90 revolutions per minute were installed. The question of the alteration of the present tonnage regulations is also dealt with. In the second part of the paper mechanical and structural considerations are discussed. Under this heading such items as cylinder liners, cylinder covers, valves, pistons, piston rings, piston cooling, crank shafts, balancing, receive attention, while the equally important questions of lubrication and the ability of the engine to use boiler oil are dealt with, as well as the general complication of the engine. After carefully considering the points above enumerated, the author is led to the conclusion that the mechanical and structural advantages and disadvantages of the four-stroke cycle and the two-stroke cycle engine are at present fairly equally balanced between the two types. There is no reason, therefore, why the two-stroke cycle engine should be less reliable than the four-stroke cycle engine, which is confirmed by a study of the records of voyages made by modern ships engined with motors of the former type. This being so, the question as to which is the best type of engine to adopt depends on the fundamental considerations discussed in the earlier part of the paper. On these points the author considers that the two-stroke cycle engine shows a marked advantage, and that this advantage will be greatly increased with further experience, especially if the existing tonnage regulations are revised.

INSTITUTION OF ELECTRICAL ENGINEERS.

AT a meeting of the informal section of the Institution of Electrical Engineers, held on Monday, November 20th, Mr. F. J. Pearce opened a discussion on "Electric Light Wiring." Mr. W. E. Warrilow was in the chair. The various wiring systems were first reviewed by Mr. Pearce, who also criticised the systems in detail. Wood casing, slip and screwed joint conduits, galvanised and sherardised conduits, cab tire and metal sheathed wires were considered and various methods of installation were discussed. Mr. Pearce also dealt with the various atmospheric conditions that are met with, such as dry, humid, dust-laden, wet acid-laden, fume-laden, &c. He did not think that switch fittings were suitable for the most trying conditions, such as those imposed by acid and fume-laden atmospheres. The discussion which followed Mr. Pearce's remarks resulted in several interesting points being raised. Mr. A. F. Harmer thought that where conditions did not absolutely prohibit it there was much to be said for the system of running V.I.R. wires on porcelain cleats. Mr. P. Rosling asked what experience there was of the durability of cab tire cable, and Mr. Pearce exhibited some specimens that had been in use ten years and still appeared in excellent condition.

Mr. C. J. Banster, Mr. W. F. Bishop, Mr. J. R. Bedford, Mr. P. D. Dale, Mr. P. Dunsheath, Mr. W. Fanghanel, Mr. E. H. Freeman, Mr. A. G. Hilling, Mr. L. M. Jockel, Mr. F. E. Phillips, Mr. W. E. Rogers, Mr. F. A. Selater, Mr. A. T. Smee, Mr. G. J. D. Scott, Mr. E. J. Turle, Mr. C. T. Walrond, Mr. W. E. Warrilow, and Mr. W. L. Wreford also spoke. In his reply, Mr. Pearce said he was unable to devise a scheme that completely overcame the difficulties of cold storage rooms ; also that condensation in conduits was not met with anything like as often as is supposed.

BALL BEARINGS.

"THE Development of Ball and Roller Bearings" formed the subject of a lecture delivered by Mr. A. W. Macaulay at the meeting of the Junior Institution of Engineers on the 10th ult. The lecturer began by referring to the recent contributions of Messrs. Palmgren and Heathcote, and offered tentative suggestions for commercial tests—the practical outcome of such theoretical researches. After briefly describing the progress of development and design of both types of bearings during the past twenty years, Mr. Macaulay passed on to discuss ball and track conformity, the considerations underlying load-carrying capacity, the margin of safety, and, as a basis of commercial running tests, the introduction of overload conditions, so that such tests might be completed in reasonable time, some very useful data being given in this latter connection. Attention was also directed to ball and roller bearings in service, maintenance, limits, and applications to marine, crane, rolling stock, railway and other work, both from the commercial and technical aspects.

Four principal suggestions for the conditions under which the commercial tests should be carried out were :—(1) To submit the bearing to 100 hours' continuous running under pure radial load at 1000 revolutions per minute, with the intention of subjecting the balls and races to such a number of revolutions in a reasonable time as would just produce flaking from excessive fatigue, the result to be the average obtained from at least half a dozen bearings ; (2) the test load to be twice the listed capacity ; (3) the probable life under other loading to be derived from the cubic law, *i.e.*, the life at normal listed load (half test load) would be 800 hours, and so on ; (4) these severe conditions representing an admission of a definite life to a bearing must be considered in relation to the majority of applications in actual service.

Many practical points were brought forward in the ensuing discussion, whilst the consensus of opinion appeared to indicate that the proposed tests were not any too severe.

Railway Matters.

THE compensation that is being voted by the various companies to the directors displaced under the grouping scheme is based on four years' purchase of the fees they have been drawing.

THE Government is to be congratulated on its appointment, in the person of Mr. W. B. Clode, K.C., of a successor to the late Sir Francis Gore-Browne, as Chairman of the Railway Rates Tribunal. Mr. Clode will bring to his new office a knowledge of railway law which will be exceedingly useful.

THE Government of India has sanctioned four crores of rupees (roughly £2,500,000), to meet capital expenditure on the Burma railways. The scheme includes new engines, carriages and wagons, the doubling of over 90 miles of the Mandalay line, and the improvement of sidings, bridges, workshops and permanent way.

THE Midland and the North-Eastern are among the companies which give their proprietors a free ticket over their own system to allow them to attend the shareholders' annual meetings. At the special meeting at Derby the other day some of the Midland proprietors were wishful to know what would be the future course in this matter.

AT the meeting on the 23rd ult. of the proprietors of the North London Railway to approve of its complete absorption by the London and North-Western, the chairman said that the North London had carried 1551 million passengers in fifty years, or thirty-three times the population of Great Britain, and had never lost the life of a passenger in an accident to a train.

THE International General Electric Company has been awarded the contract for the electrification of 30 miles of track of the Mexican Railway Company, Limited, between Orizaba and Esperanza, on the main line between Mexico City and Vera Cruz. The section contains many steep gradients, and the electrification project calls for the expenditure of between 2,000,000 dols. and 2,500,000 dols. The electrification of this stretch of line will be the first on a main line steam railway in Mexico.

THE Caledonian Railway Company has given notice of its intention to apply for a Provisional Order which will include powers to "acquire or to construct, erect and lay out an hotel and a golf course and relative works, or to complete the construction, erection and laying out of the hotel and golf course and relative works already partially constructed and laid out on such lands by the company known as Gleneagles, Limited, and to equip, furnish, maintain, manage, regulate, and carry on the same."

THE Provincial Government is considering plans for the electrification of the Temiskaming and Northern Ontario Railway, at a cost of approximately 9,000,000 dollars. It is contended that with the enormous water powers in the Northland, much of which is at present undeveloped, the substitution of electric power for steam power would effect a considerable saving. It is understood that the Provincial Ministers are favourable to the project, and that the Lieut.-Governor-in-Council will direct that the change be made.

IN this column, on the 17th ult., allusion was made to the seventieth anniversary of the opening of the Chicago, Rock Island and Pacific Railroad. This event has prompted our New York contemporary, *The Railway Age*, to ask whether the centenary—centennial is the term employed—of the American railways is to be suitably observed. It was on July 4th, 1828, that Charles Carroll, of Carrollton, the then only surviving signer of the Declaration of Independence, drove the first spike of the line that is now part of the Baltimore and Ohio.

THE Railway Clearing House has informed the National Chamber of Trade and the Association of British Chambers of Commerce, which had applied for a reduction to be made in the rates for ordinary and traders' season tickets, that the railway companies feel that at the present they have gone as far as they can reasonably go in the direction of reducing their fares and rates. The qualification for traders' season tickets will, however, be reduced from £600 to £500 per annum for each ticket as from January 1st, 1923. We would add that when passenger fares, &c., were increased in September, 1920, the qualification was increased to £1000 a year. It was reduced to £600 when control ceased in August, 1921.

IN a paper on "The Development of Automatic Train Control," by Mr. W. J. Eck, signal and electrical superintendent of the Southern Railway, read before the Western Society of Engineers, Chicago, on October 23rd, it was said that there are more than 5000 patents on file in the United States Patent Office on the subject of train control, and only about a score have been considered worthy of service tests and development under actual operating conditions. In 1888 Axel S. Vogt, of the motive power department of the Pennsylvania Railroad, devised the first automatic stop used in the United States. A feature thereof was a glass tube mounted on the locomotive cab, which was fractured by an overhead contact should the engine pass a signal at "danger." This scheme was abandoned after the tube had been broken by an icicle in a tunnel, on which occasion the passengers were rescued only after some difficulty.

ONE of the last acts of the retiring Government of Argentina was to approve the plans and estimates of the State Railways Administration for the construction of a network of light lines in the Patagonian territories. The lines are designed to open up and develop this vast region, which so far has only been "scratched" in an economic sense. Approval was formally given for the commencement of construction and to the outlay of 32,842,755 paper pesos. The system so far planned embraces some thousand miles of railway of 2ft. 6in. gauge, over which it is estimated the working costs will be only 8 pesos per 1000 kilometre-tons. One section will connect with the recently acquired private line of the Central Chubut Railway. At the same time the Government approved the construction of the line between San Antonio and Carmen de Patagones, to connect the Patagonian system direct with Buenos Aires by linking up with the Great Southern Railway, and voted a further grant for the investigation of the problem of finding an inlet to the Federal capital for the State railways.

Notes and Memoranda.

THE Union Minière et Société Géomines, Belgian Congo, has exploited deposits of tin and are at present capable of producing from 600 to 1200 tons per annum of cassiterite containing from 72 to 74 per cent. of SnO_2; 625 tons were produced in 1921. This is not treated on the spot, but is shipped to Antwerp where it is handled by a special plant established by the Société Métallurgique de Hoboken.

WHEN the several iron and steel companies which it is proposed to institute in India are in working order they will have a total estimated output of 1,500,000 tons of pig iron and 1,000,000 tons of steel annually. Production on such a scale will result, obviously, in the erection of more mills for the out-turn of finished iron and steel materials, such as sheets, plates, bars, joists, &c., in India.

OUT of nearly 2000 coal pits active in the Donetz district of Russia in 1913, only from 180 to 190 are now at work, these being the best; but a large number of the remainder are being maintained in good order. The production of coal amounted to about 288,000 tons in June, 1922, but has greatly fallen off since that date on account of the migration of the miners in large numbers, particularly the hewers. Out of a total number of 100,000 officials and workmen employed in the Donetz in June about 14,000 were hewers, but in September their number was only 7000.

IT has been found in an American water turbine factory, according to the *Engineering News-Record*, that rubber forms an excellent material for the sealing rings between the rotating and fixed parts of turbines. The rings now being made are of a thickness that leaves no free clearance between the moving and stationary parts, and the hardness used is about equal to that of motor car tire casing. The results are: No danger of seizure, no leakage and negligible wear after almost a year's operation under adverse conditions; and no damage to the interior of the turbine from rubbing between rotating and stationary seal rings.

SOME progress has been made in the Congo Katanga country with the exploitation of coalfields, found principally in the Luena and Lukuga (Lake Tanganyika) districts. The coal is rich in volatile matter and unsuitable for producing coke, but in a crushed form can be used for locomotive and other boiler fuel. The reserves at Luena are estimated at 16 million tons, while the larger deposits (estimated at about 1000 million tons) on the Lukuga have been made the subject of successful experiments for locomotive purposes. A company with a capital of 10 million francs has been formed for the purpose of developing the coal resources of this district.

ACCORDING to Dr. F. W. Aston, if we could transmute into helium the hydrogen contained in one pint of water the energy so liberated would be sufficient to propel the Mauretania across the Atlantic and back at full speed. With such vast stores of energy at our disposal there would be literally no limit to the material achievements of the human race. The possibility that the process of transmutation might be beyond control and result in the detonation of all the water on the earth at once is an interesting one, since, in that case, the earth and its inhabitants would be dissipated into space as a new star, but the probability of such a catastrophe is too remote to be considered seriously.

IN an article on the development of brass forging, in *Forging and Heat Treating*, Mr. O. T. Roder points out that brass forgings may have a tensile strength as high as 65,000 lb. and a yield point of 35,000 lb., as compared with 30,000 lb. and 15,000 lb. respectively for sand castings. Dimensions, he says, can be held to 0.005in. on diameters and 0.010in. on lengths. The cost of polishing, buffing and nickel plating is reduced to a minimum owing to the uniformity, smoothness of the surface and freedom from scale. Turning speeds on machining can be greatly increased, tools stand up much longer and the material is very free cutting, and production is, therefore, greatly increased. One of the noteworthy advantages obtained in the use of brass forgings is the saving of high-priced metal and the elimination or minimising of subsequent machine operations.

THE moulding mixture used for plaster-cast brass moulds may, according to the *Metal Industry*, comprise 7 parts plaster of Paris, 4 parts asbestos flour, and 1 part very finely divided fire-clay, care being taken to see that it is free from grit. The oven for baking should be one in which the heat may be regulated by a pyrometer, but should not contain sand cores. The process of pouring needs careful attention, and the selection of a suitable alloy is equally important. A characteristic brass, of manganese-bronze colour, a tensile strength of 70,000 lb. per square inch, and elongation of over 30 per cent., is composed of 66 per cent. copper, 32 per cent. zinc, 1½ per cent. tin, and ½ per cent. aluminium. Copper-lead alloys necessitate a vehicle, commercial virgin antimony being most suitable in this respect. Plaster moulds may be used over and over again by regrinding and adding one part to two parts stock mixture.

FOR the last three years Professor Honda and his pupils at the University of Sendai have, according to *Nature*, been investigating the conditions under which rods of solid dielectrics permanently charged with positive electricity at one end and with negative at the other could be produced. In the most recent work of Mr. M. Satô, described in the June issue of the Science Reports of the University, a tube containing a molten dielectric and having electrodes at its ends connected to the positive and negative terminals of an electrical machine. The dielectric is allowed to solidify slowly from each end, the middle portion remaining liquid longest, and when the rod of solid dielectric is extracted from the tube, it is found to be charged positively at one end and negatively at the other, and the charges will continue apparently for years. If the rod is cut into short lengths each length is permanently charged, the amount of the charge being proportional to the distance of the length from the middle of the rod. According to Mr. Satô, these "electrets" are due to the ions held in fixed positions by the solidification of the dielectric.

Miscellanea.

AT the last meeting of the Institution of Electrical Engineers it was announced that Dr. J. A. Fleming had been elected an honorary member.

BY the end of this year the two famous Ontario gold mines, the Hollinger and Dome, will have produced, according to *Canada*, gold to a total of about 79,000,000 dols., of which Hollinger's share will be about 60,000,000 dols.

EXTENSIONS to the coal piers at Hampton Roads, United States, which will more than double the local coal-handling capacity, are either already under way or will be started early in 1923. These improvements will represent an aggregate expenditure of about 6,500,000 dols.

AS a means of reviving the cement industry of Kent, it has been suggested that English roads, instead of being constructed of macadam, should be made of concrete. Sir Henry Maybury, Chief of the Road Department of the Ministry of Transport, has agreed to meet a deputation to discuss the question.

DRILLING for iron ore on the north shore of Lake Athabasca, Alberta, 500 miles north of Edmonton, will be undertaken early next spring by the newly organised North-West Steel Corporation, of Chicago. Samples have shown the ore to be a very high grade of hematite, suitable for the manufacture of Bessemer steel.

AT a meeting of timber merchants held in Leeds recently it was decided to form a timber exchange in the city, under the style of the Northern Timber Exchange, with headquarters at the Hotel Metropole. It was stated that the Exchange would be to the mutual benefit of timber merchants, importers, saw mills, and allied trades.

IT is reported that some very important power development plans are being considered in the north country of Canada. An important group of Toronto, Montreal, and New York business men has undertaken to develop certain water powers, and a new company will be formed very soon. All the power from the first unit of this new development is said already to be contracted for by mines not far from the power site.

THE production of pig iron in the United Kingdom in October amounted to 481,500 tons, and of steel ingots and castings to 565,200 tons. Although the production of pig iron is the highest since the coal stoppage, it is still only 56 per cent. of the average monthly production of 1913. Included in the production of pig iron are 129,900 tons of hematite, 151,100 tons of basic, 134,000 tons of foundry, and 31,500 tons forge pig iron.

THE jubilee issue of *The Electrical Review*, which was issued on November 17th, is a publication of great interest to electrical engineers. It contains many articles by prominent men in the electrical profession who are connected with different classes of electrical work. One of the most interesting articles is by Sir Philip Dawson, who deals with the future of railway electrification and its connection with power supply and distribution.

A SCHEME of hydro-electric development on the east branch of Bear River, Nova Scotia, is projected. The probable cost is put at 11,500,000 dols., and electricity would be supplied along the north shore of Nova Scotia from Yarmouth to Middleton. Mr. K. H. Smith, chief engineer of the Nova Scotia Water Power Commission, is satisfied that the scheme is sound, and the work has advanced so far that the Commission will be prepared in two or three weeks to suggest a definite contract for the approval of the Town Council. Eight distributing stations are proposed.

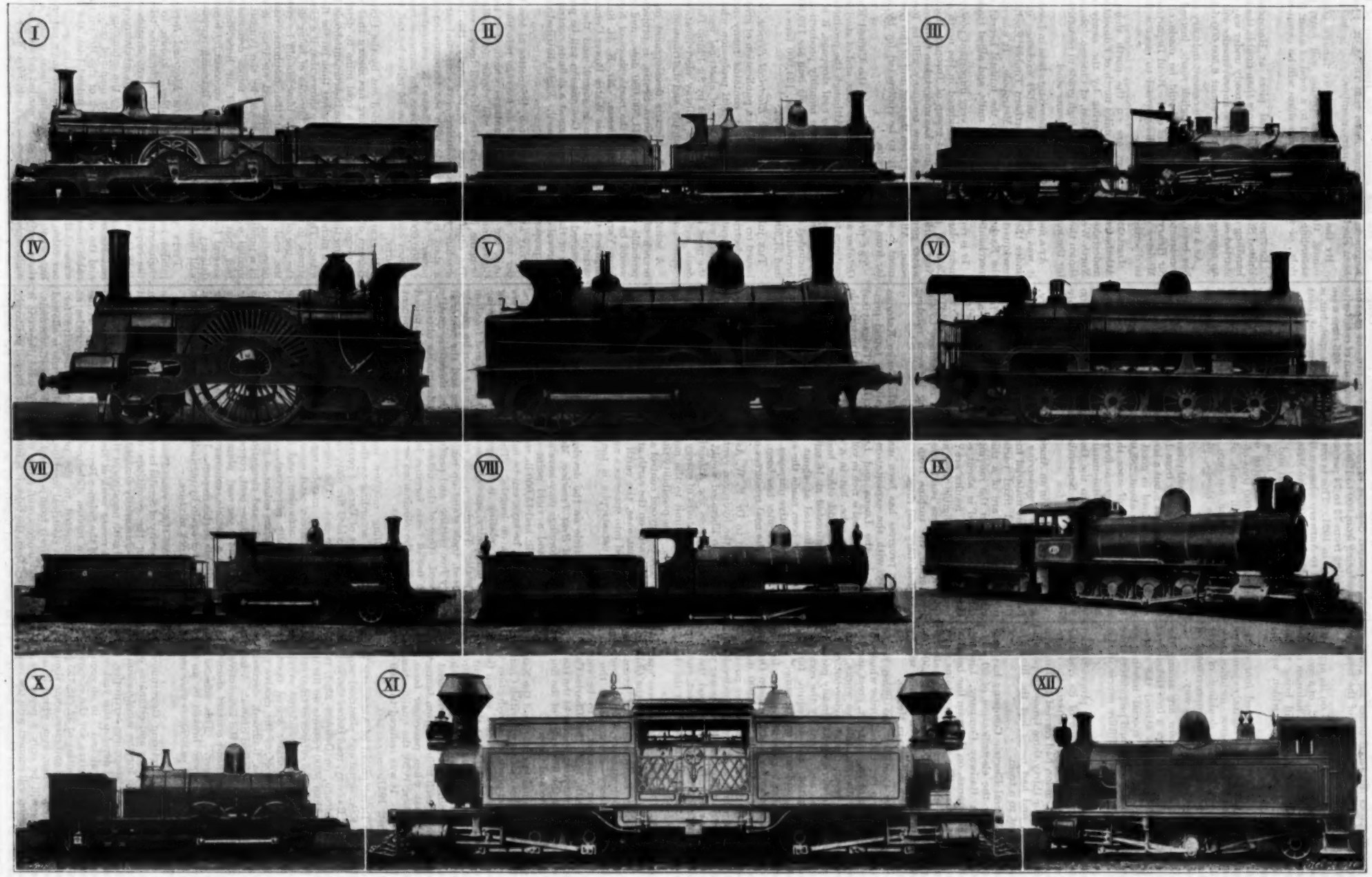
COAL at about 9s. per ton, briquettes at less than 25s. per ton, and electricity at an average rate under ¼d. per unit, are among the advantages which, it is hoped, the Government of Victoria will confer on Melbourne by bringing into operation the Morwell brown coal scheme. The supply of coal is to begin shortly, the briquetting machinery will be producing next year, and early in 1924 a start is to be made with the transmission of electric power. The complete scheme is estimated to cost £4,500,000, and has as its basis the immense resources of brown coal at Morwell, some 86 miles by rail from Melbourne.

EXPERIMENTAL work carried out by the United States Bureau of Mines at Pittsburg has shown that when the geophone is to be used in a coal mine to detect sounds coming through the strata the instrument should be placed on a niche or shelf of coal rather than on the floor of the mine. The experiments have shown that if a blow is to be struck in a mine with the purpose of being detected by the use of the geophone the blow should be struck upon the coal. A new use for the geophone, namely, the detection of leaks in compressed air lines, is described in a publication recently issued by the Bureau. Experimental work in Arizona metal mines demonstrated the fact that leaks in compressed air lines buried under several feet of earth could be successfully located. The delicacy of the instrument for listening purposes is now well demonstrated.

FIFTY years ago, states the *Electrical Review*, in its jubilee issue, the only "cables" known to electrical engineering were those used for submarine telegraphy—the cores of which consisted of seven strands of No. 20 B.W.G. copper wire, enclosed in an insulating waterproof sheath of gutta-percha. To-day the submarine cable core consists of the same materials modified only in detail; and the excellence of the work of the British submarine cable manufacturers may be judged from the fact that some of those original cables are still in use. Since then our cable makers have maintained their pre-eminence—but what immense progress has been made! Whereas those early telegraph cables carried currents measured in milliampères, at a pressure of, say, 50 volts, we now have power cables 4in. in external diameter, capable of carrying 15,000 kilowatts at 33,000 volts between phases. Moreover, the makers are prepared to supply cables for twice that pressure. By no other means known to engineering could a power of 15,000 kilowatts be transmitted through an aperture 3in. in diameter—the external diameter of the lead sheath of a 33,000-volt cable.

LOCOMOTIVES BUILT AT THE HYDE PARK WORKS, GLASGOW

(*For description see page 570*)



I, Four-coupled Engine for the Midland Railway, 1870—*II, Goods Engine for the Midland Railway,* 1876—*III, Four-coupled Tender Engine for the Midi Railway of France,* 1881-2—*IV, 8ft. 2in. Single-driver Engine for Egypt,* 1862—*V, Four-coupled Tender Engine for the N.E.R.,* 1873—*VI, Eight-coupled Tank Engine for the G.I.P. Railway,* 1879—*VII, Express Engine for the Caledonian Railway,* 1884—*VIII, Freight Engine for the Western Australian Government Railways,* 1897—*IX, Eight-coupled Tender Engine for the Central South African Railway,* 1902—*X, Tank Engine for the G.N.R.,* 1866—*XI, Fairlie Engine for the Mexican Railway,* 1889—*XII, Fell's System Side-tank Engine for New Zealand,* 1886.

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TWO-PAGE SUPPLEMENT—NEW BARRAGE ON THE VAAL RIVER.

THE ENGINEER.

DECEMBER 1, 1922.

Bearings and Bearing Metals.

THE whole subject of bearings and their lubrication has undeniably made very great advances in recent years, not only in improvements of design and practice, but also in regard to the scientific knowledge which lies, or should lie, at the base of such practice. The advance in fundamental knowledge has followed two main directions. One has been pursued by W. B. Hardy and his co-workers, and relates to what is called "boundary lubrication." It deals with the effects upon friction produced by the presence of extremely thin films of lubricant—films whose thickness is of the order of a layer of single molecules. While the results obtained in the study of such conditions are interesting and important, it may perhaps be urged that they do not apply to any conditions which can occur—except momentarily—in engineering practice. While this may or may not prove to be the case, the fact remains that this line of investigation has added and is still adding new fundamental facts to our knowledge of the phenomena of friction and surface lubrication, and it may confidently be anticipated that sooner or later the bearing of these facts upon engineering problems will become plain.

The second line which has been pursued in recent researches, notably by Stanton—whose Hawksley Lecture to-night at the Institution of Mechanical Engineers may throw a new light on this subject—and by his colleagues, relates more directly to practical problems. These researches have dealt, among other things, with the effect of high pressures on the viscosity of oil, with the influence of the chemical composition or nature of an oil upon its lubricating properties and latterly with the behaviour of oil in markedly excentric journals. Here we meet with such important facts as the necessity for the presence of a small amount of fatty acid in an oil that is to give the best lubrication results and the startling fact that hydrodynamic flow can and does occur in an oil film of a thickness no greater than that equivalent to a layer some five thousand molecules thick. Such a layer, measured in ordinary units, is, of course, excessively thin, and one would have hesitated to think that flow could occur in it, were it not for experimental results. Taken together, all this new knowledge would tend to confirm the view that in any reasonably well-designed and well-lubricated bearing, the metallic surfaces are never in contact, and that the behaviour of the bearing would be quite independent of the nature of the metallic surfaces themselves, so long as these surfaces were strong enough to resist the maximum pressure of the oil film. Yet actual ascertained fact and the experience of many years goes to show that the contrary is the case, at least to some extent. On this ground, the continued use of special and sometimes expensive bearing metals is justified, and one is led to inquire what is their mode of action—how does their chemical composition and physical structure really affect the behaviour of a bearing in which the rotating surfaces are supposed to be constantly separated by a film of oil, however thin? One view which has long been advocated is that an effective bearing metal must consist of a hard constituent, said to be "capable of bearing the load" embedded in and supported by a much softer, but very ductile matrix. It is suggested that the hard, but usually brittle, constituent alone would fail under the load without the support of such a matrix, while the soft matrix alone would wear away too rapidly, even if it could support the pressure. It is further supposed, on this view, that after a little time the hard constituent projects from the surface of the bearing, thus leaving grooves or channels, out of which the soft matrix material has been depressed, to allow more room for oil circulation. There are, however, difficulties about accepting this fairly plausible explanation. In the first place, there is no real reason for supposing that under hydrostatic pressure such as must be exerted by a continuous film of oil, the softer constituent would show any tendency to be depressed below the general level of the surface, while examination of used and worn bearings made of bearing alloys of the kind in question actually shows no appreciable difference of level as between the hard crystals and the soft matrix. The question therefore arises whether the action of these complex bearing metals, if it is real at all, is not of a very much more subtle nature. It is quite possible, for instance, that a certain small amount of chemical interaction takes place between the materials of the bearing and the oil itself, possibly resulting in a "boundary film" of a special nature being formed as between oil and metal. Where we have to deal with the flow of such excessively thin films of oil, it is quite possible that the exact nature of the bounding surface between oil and solid may play a large part in determining the frictional resistance.

We cannot further pursue the details of these interesting problems, but enough has, perhaps, been said to show that there are many problems connected with bearings and bearing metals which may prove to be of very great practical importance. The best composition and structure of bearing metals for many purposes is still a very open question; there are wide divergences of opinion and practice, while in many cases the question is of considerable economic importance in view of the high cost of some of the metals involved. Here a fuller knowledge of what really matters in a bearing metal would be the first step towards the solution of the question, "What is the best bearing metal to use?" in each particular case. The metallurgy of this group of alloys is sufficiently advanced to make it a relatively simple matter to provide, within the range of available compositions and properties, a very excellent approximation to whatever the engineer may require for his bearings. It is, however, essential that the engineer should know very definitely what is desirable, and here it is to be hoped that the advance of knowledge along the lines referred to above may provide a sounder basis than the conflicting view derived from varied experience.

Railways and Unemployment.

ONCE again it is being suggested that the railway companies could, with the assistance of the Government, find work that would relieve a considerable amount of unemployment. We fear that the extent to which such relief can be carried is much less than is generally supposed. Such works as widenings, connecting lines, enlargements of stations, need, as we pointed out in a leading article in our issue of October 14th last year, the preparation of plans—progress plans as well as the complete scheme in many cases—of quantities and the making, issuing and acceptance of tenders. All these things take time, and are usually a question of months. But before even as much progress as this can be made, there is a difficulty to be overcome, the extent of which is hardly appreciated. The railways of this country—we are referring now to the lines, stations, &c.—are about to be what we may call revalued. Under grouping, a line or a station, hitherto of prime importance to its owning company, may decrease in value, in view of the fact that another line or another station will be available for the same service. In like manner, the necessity for widening a line, enlarging a station or yard may be gone, because another company will bring to the group an alternative route or a second station or yard. These additional facilities are

part of the advantages that will follow grouping, and the various companies keep them in view, but, as yet, they have not had the time to work out the necessary schemes and to determine what shall be done. It is true that certain works will have to be carried out in any circumstances. But even with them, there is the difficulty that no company, in view of grouping, will spend money on capital works. The companies naturally say, "Let the group do the work; it will get the benefit." Lastly, there remains the fact that for the railways, as for all commercial concerns, the future is, as yet, still uncertain. However badly some works may be needed, it were better, as matters are, to carry on for a while longer.

The principal direction in which railways can give employment is by proceeding with electrification; but we recognise that some of the difficulties we have mentioned may stand in the way of the immediate realisation of these schemes. The terms for the grouping of the Southern Group have been agreed to by the respective proprietors, but are their officers agreed as to the method of electrification to be adopted on the South-Eastern and Chatham section? The electrification of the Tilbury section of the Midland Railway east of Barking is another scheme that has been named as offering work for the unemployed, but we suggest that it is quite likely the London, Midland and Scottish companies may prefer to wait until their grouping is complete. For the same reason, the electrification of the Manchester and Oldham lines of what was the Lancashire and Yorkshire may have to wait. In fact, the only electrification works that are free of any such obstruction are the extension of the Brighton Company's line to Brighton and the installation between York and Newcastle. In case it should be suggested that the London Electric Railways Company could proceed with its scheme for twin tubes under the Thames, the extension to Kennington, &c., we would point out that it has no powers for this, and that, as private property will be interfered with, the Government cannot greatly accelerate the passage of the necessary bills. What might, however, be done is to proceed with the Wimbledon and Sutton Railway, as it has been sanctioned since 1911. It was stated by Electric House, on Wednesday last, that the total sums to be expended on further tube railway extensions in connection with the Government plans for providing employment would amount to ten million pounds. But it is quite clear that, as plans are only being considered, work cannot be begun at once and probably not for several months.

We do not yet know in detail what happened at the conference between the Prime Minister and railway managers held a few days ago, and it may be that the Prime Minister will find himself in the happy position of being able to announce to-day the adoption of means of surmounting some of the difficulties we have mentioned. But we suggest that it would be as well if the public did not found hopes of too rosy a kind on the ability of the railways to employ large numbers of men at once on constructional work. We are confident that the railways will do all that is humanly possible, but it is difficult indeed to see how they can take steps that would lead to the employment of large numbers of men during the winter months. The most hopeful prospect is that they may be able to see so far into the future that they can place at once orders for material and rolling stock. Such orders would have the effect of spreading relief over a large area, and, by giving employment in one of the most hardly hit of all industries, would obviate the dislocation of labour that would result if mechanics were turned over to navvy's work.

Institution of Mechanical Engineers

An extra general meeting of the Institution of Mechanical Engineers was held in London last Friday evening for the purpose of discussing Mr. William Reavell's paper on "Air Compressors," presented at the Paris meeting in June, and of listening to the reading of and discussing an additional "Note on Testing Air Compressors," which Mr. Reavell had prepared to supplement his original paper. A short abstract of the main paper appeared in our issue of June 23rd last, and elsewhere in this issue we reprint in full the "note" on testing.

Mr. Harold Allen, who took the chair in the absence of the President, Dr. Hele-Shaw, said that the original paper had undoubtedly been greatly strengthened by the additional note. Few papers had been written with air compressors as their subject, yet compressed air was now being used to a greatly increased extent, one very important instance being in connection with Diesel engines. Rotary air compressors were advancing very rapidly as a result of the progress made in metallurgy during and after the war. In the matter of the measurement of air, the precise method adopted was of less importance than the adoption by all of a uniform method, for progress was dependent more upon our means of comparison than upon our means of absolute measurement. He welcomed Mr. Reavell's suggestion that the National Physical Laboratory should undertake the preparation and testing of a standardised nozzle form of the Venturi meter type for the measurement of air, and trusted that it would be given effect to.

Mr. A. Bailey, of the National Physical Laboratory, dealing with the suggested standardised test, said that the subject had engaged attention at the Laboratory for the past twenty years. The standardised method adopted consisted of the use of a Pitot tube. This instrument was very adaptable, and could be used to measure the total head at any point in the stream of air. In 1911 they had succeeded in proving that knowing the density of the air, the Pitot tube reading and the static pressure, the velocity could be calculated very accurately from the expression $P = \frac{1}{2} \rho V^2$. With nozzles of the type described in the note on testing, the National Physical Laboratory had had no experience. Tests had, of course, been made at Teddington on flow meters fitted with nozzles, but they were made in connection with the meters apart from the nozzles. Although he was not in a position to criticise the use of nozzles for the measurement of air flow, he thought some difficulty would be found in determining where the nozzle should be placed. In this connection he noticed that Mr. Reavell's paper indicated several different positions for them. As regarded the variation in the nozzle coefficient, this factor would, as the author said, depend upon the thickness of the plate. It would also, he thought, vary with the velocity of the air through the plate or nozzle and with the kinematic coefficient of viscosity, η/ρ. In response to a request from Mr. E. R. Dolby for some information regarding the hot wire anemometer, Mr. Bailey disclaimed credit for the invention of that ingenious instrument, and said that he himself had only been responsible for applying it as a means of determining the direction of flow in air. The instrument consisted of a platinum wire heated by a current of electricity and a Wheatstone bridge, whereby variations in the resistance of the wire produced by the greater or lesser cooling effect of the current of air striking it could be determined. Velocities down to ½ft. per second could be measured by the device. It was, however, not suitable for such high velocities as those encountered in the testing of air compressors.

Mr. R. L. Quertier, dealing with the question of valves in air compressors, remarked that in compressors and steam engines the actions were reversed in so far that in the one the action was a building-up process, while in the other it was a pulling-down one. In compressors it was practicable to use automatic valves, but in steam engines the valves had to be mechanically operated. About ten years ago many air compressor makers used piston or other forms of mechanically operated suction valves with the object of avoiding the attenuation of pressure accompanying the operation of automatic valves. To-day practically all makers used automatically operated suction valves. The power used to drive mechanically operated valves was just about equal to that lost with automatic valves. It was therefore decided to use the latter, for by doing so the design of the compressor could be simplified and cheapened. The gudgeon valve in the Reavell quadruplex compressor was a mechanically operated valve, but it did not entail the loss of power associated with the driving of other forms of mechanical valve.*

Mr. H. Haerle severely criticised the receiver method of testing air compressors. It was amazing, he said, how gullible purchasers of air compressors were, and for what a length of time the receiver test had been accepted by them as yielding satisfactory results. Actually it was exceedingly difficult to obtain accurate figures from such a test. It was difficult to measure the true volume of the receiver when under pressure, to eliminate leakage losses, and to determine the mean temperature of the air in the receiver. He was therefore glad to note that the author did not lay chief stress on this method of testing. The Pitot tube method suffered from the fact that the velocity was not uniform across the section of the air current, and that some doubt must always exist as to what factor to apply to the maximum reading taken on the centre line in order to obtain the true mean value. The nozzle or diaphragm method was undoubtedly the best, but it was essential to have a standardised form with standardised formulæ for use therewith and a standardised method of using the nozzle. A table of exact proportions should be provided so that any one might be able to reproduce the standard nozzle in any size. With it results in error by 1 or 2 per cent. could be obtained instead of by 10 or so per cent. as at present.

Captain H. Riall Sankey welcomed Mr. Haerle's support of the nozzle test, and submitted the suggestion that the Institution and not the National Physical Laboratory should undertake the work of standardisation.

Mr. G. T. Gillespy put in a mild defence for the receiver test on the ground that there was a wide difference between an accurate laboratory test and no test at all, and that there was a scope for a testing method which, while it gave a result in which there might be a fair error, was familiar, straightforward and simple to carry out. The usual method of interpreting the results of a receiver test was not accurate, and generally did less than justice to the compressor. His method consisted of plotting a curve of the rise in pressure in the receiver on a time basis, or, better on a basis of compressor revolutions, so that speed variations might be eliminated. Then the efficiency of the compressor at any pressure covered by the curve was calculated from the formula

$$E = \frac{Q \tan \theta}{p_o q}$$

in which Q was the receiver capacity, q the cylinder capacity of the compressor, p_o the inlet pressure, and θ the angle between the horizontal axis and the tangent to the curve at the point representing the pressure in question.

Mr. E. R. Dolby said that the author had described in the main paper a cooler in which the compressed air was passed through pipes surrounded by solid water. He would suggest that an evaporative condenser type of cooler might be used, one in which water in the form of mist from a series of nozzles was allowed to settle on the tubes carrying the compressed air, and there evaporated. Had Mr. Reavell any knowledge of such a form of cooler having been used, and, if so, what were the results?

Mr. Copping informed the meeting that since last May a Committee representing fan manufacturers, the Admiralty, and the Office of Works had been sitting with a view to determining a standard method of testing low-pressure fans. This inquiry had been begun at the instance of the Institution of Heating and Ventilating Engineers, and he would suggest that it might by co-operation be extended to cover the standardisation of testing methods for air compressors.

Mr. Oxlin, dealing with Mr. Copping's suggestion, said that the testing of low-pressure fans and blowers must call for quite different methods from those suitable for testing air compressors. For fan testing, an orifice was out of the question in view of the large volume of air to be measured. A Pitot tube placed in the air current was also inapplicable because the disturbance created by the fan runner rendered it impossible to obtain readings of any value. It was probable, however, that a Pitot tube placed on the inlet side was the best method of measuring large volumes of air.

Mr. E. T. Vincent criticised with great force the design of air compressors for use in conjunction with Diesel engines. The Diesel engine, he said, had outstripped the air compressor in trustworthiness. Most of the accidents which had occurred were caused not by any failure on the part of the engine, but by failure in the compressor. The reason, in his view, was not far to seek. It was usual in a twin-engined motor ship to install two compressors, either of which was sufficiently large to supply the air to both engines. The compressors therefore under normal conditions ran at half load, with the result that if they were designed for equal distribution of work in the three stages under full load, the high-pressure stage would be greatly overloaded, so much so that the practice of installing compressors of twice the capacity normally required instead of being a provision for safety simply invited trouble. To bring out his point more clearly he gave the following figures which he had calculated:—

At Full Load.

	L.P.	I.P.	H.P.
Clearance, per cent.	4	5	10
Compression ratio	4.1	4.1	4.1
Temperature	340	340	340

At Three-quarter Throttle.

	L.P.	I.P.	H.P.
Clearance, per cent.	4	5	10
Compression ratio	3.9	4.1	6.23
Temperature	338	340	442

It would be seen that while at full load the distribution of work in the three stages was uniform, at three-quarter throttle the high-pressure stage was greatly overloaded. If the clearance volumes were readjusted so as to increase the size of the intermediate and high-pressure cylinders it was possible to obtain a much better result. Thus, with clearance volumes of 4, 15 and 30 per cent. respectively the full load figures for compression ratio and temperature could be the same as before, while at three-quarter throttle the figures obtained would be:—

	L.P.	I.P.	H.P.
Clearance, per cent.	4	15	30
Compression ratio	4.3	5.1	4.9
Temperature	351	390	381

Mr. Reavell remarked that several of those taking part in the discussion had already been replied to by others. Mr. Gillespy's method of using the results of a receiver test was new to him, but there was food for thought in it. He had never heard of Mr. Dolby's suggestion for cooling compressed air having been tried in practice, but while it might be worth studying, it was not clear what advantage it would have over

* A fully illustrated description of the Reavell quadruplex air compressor, with a report on the test results obtained from it by Captain H. Riall Sankey, appeared in our issue of July 22nd, 1921.

the counter-current method. He was glad to listen to Mr. Vincent's remarks, for he had been fighting the same battle for years. There was no question but that Mr. Vincent was right in his views. The alleged ample margin of safety provided undoubtedly brought Diesel engine compressors very near the edge of a precipice. He cordially agreed with Captain Sankey's suggestion and would be very glad indeed if the Institution could become the standardising authority.

Chinese Engineering Notes.

(From our own Correspondents.)

October 19th.

Peking.

THE mid-autumn festival—China's quarter day—passed off quietly, and the Government was able to get sufficient money to tide over and meet the most urgent of its obligations. Towards the end of September the Government issued Short Term Bonds amounting to 10,000,000 dols. and bearing interest at the rate of 8 per cent. A large portion of these bonds was immediately taken up by the public. Sir Francis Aglen, the Inspector-General of Customs, has been entrusted with the service of this loan, and it is to be conducted on the same lines as the service of the Seventh Year Short Term Bonds issue of 1918. The bonds are fully secured on the deferred portion of the Russian Boxer indemnity, and at their present price of 88 per cent. to 90 per cent. are an attractive investment. The issue price was 90 per cent. The whole of the proceeds of this issue has been swallowed up in the payment of purely Chinese debts, and those foreign firms which have been hoping to get "something on account" will be disappointed. There is no change in the situation on the Peking-Mukden Railway, all efforts at mediation between the Central Government and General Chang Tso Lin having failed so far. On several occasions recently the Cabinet has sent in its resignation *en bloc*, but at the urgent appeal of the President it continues to act, although its authority does not exist outside of the walls of Peking. The scheme for a bridge across the Yangtze, connecting Hankow with Wuchang, has again been revived. Towards the end of 1921 Dr. J. A. L. Waddell, who was a member of the Commission for the new bridge over the Yellow River, was invited by the Minister of Communications to make a report and estimate the cost of the proposed bridge. He proposes the construction of two bridges to carry the steam railway, the electric tramway and vehicular and pedestrian traffic over the Yangtze and Han rivers. The first and larger of these bridges would cross the Yangtze a short way above the point where the Han falls into it nearly at right angles. The second bridge, whose orientation would be at 90 deg. to the greater bridge, would span the Han River some fifteen hundred feet or so from the bank of the Yangtze. The proposed Yangtze bridge starting from the Wuchang side consists of two through simple-truss spans, each of 240ft., an anchor arm of 394ft., a cantilever span of 590ft., the second anchor span of 394ft., and eight through simple-truss spans of 240ft. The total length is therefore 4428ft. The railway, double track, runs between the trusses with an 18ft. roadway on each side, exterior thereto, and an 8ft. footway outside each roadway. No immediate provision is made for the tramway, but when necessitated it could run between the trusses on gauntleted tracks. A vertical lift span of 326ft. with a clearance of 150ft. is provided between the anchor spans. The Han River bridge is a two-deck structure of two spans, each of 310ft. The railway is provided for on the lower and the road on the higher level. The railway span is slung from the span above and is to be raised when required by electrical machinery.

Shanghai.

"Trade is bad" is the remark one constantly hears these days, and it is said that many of the smaller firms will have to suspend operations unless trade with the interior revives soon. The year 1921 was bad from a business point of view, and 1922 is said to be even worse, and yet one gathers from the Customs trade reports that the value of trade for 1921 was of record height, and revenue collection for this port exceeded that of 1920 by about 5 per cent., and the indications are that 1922 will show a similar increase. Perhaps the general expression of a trade depression comes from the foreign piece goods, silk, and tea merchants, as machinery importers do not complain, and this is attributable to increasing industrial development, which, as the Commissioner of Customs in his annual report remarks, has taken root. The indication is that China is making big efforts to do things for herself, and the engineers, with the manufacturers behind them, are helping her to do so. This is following the usual line of development of a virgin country, which China may be said to be. That she should be found to be following any known precedent in the world's history is remarkable, as she has consistently held aloof throughout the centuries from the increasing pace of other civilised nations, being content with her own highly developed civilisation, which has followed its leisurely pace for thousands of years without the disturbance of quick transportation and communication. But once the Chinese came to see the fascination of engineering and to master its possibilities for trade development, as they have been doing for the last decade or so, the change became inevitable, and is evidenced in the demand for machinery of all classes, and there will be no stopping this demand now. In spite of political upheavals and local dissensions, the way to power is recognised as being by way of engineering development. But it can only be fostered along the big lines by establishing financial credit. That at present is the main stumbling block, but is being overcome by foreign and Chinese banking co-operation. That this banking co-operation cannot be of a governmental nature is as much the fault of the foreigners as of the Chinese, because there is a lack of unanimity in foreigners' banking policy *vis-à-vis* China's Government. But the establishment of industrial banks with real Chinese money, which could be easily obtained from individuals and concerns well advised as to the engineering possibilities of China and eager to foster them, should do much to stabilise the Government from below and the foundation be laid for international and governmental financial co-operation in the large transportation and communication development for which this country has long been waiting and now knows it wants.

Another 100,000 spindles are being added to the Japanese cotton spinning industry in Shanghai, and already buildings of the latest fireproof type are being erected for the mills. These concrete facts indicate a confidence in the future of this industry on the part of the Japanese which is certainly justified. It is evident that the Japanese are getting a hold on the cotton spinning industry in China and catering for this immense population of cotton-clad people. Their mills are run on very economical lines with efficient Japanese managers and engineers overseeing Chinese labour. The mill hands are paid what is about the equivalent of 9d. a day, for which they work twelve hours, including Sundays. In the opinion of experts the climate of Shanghai is very suitable for cotton spinning, as there is the requisite humidity in the air and nine months of the year the necessary warmth. Most of the cotton mills in China do not weave the yarn, but distribute that product throughout the country, where it is weaved on crude native looms into the coarse garments which so many of the people wear. But an increasing number of mills are installing weaving looms and using longer staple cotton imported or grown here from imported seeds, and there is every indication that in the not very distant future China will not be in the market for piece goods to at any rate the same extent as hitherto.

Thus with an authoritative central government and improved means of communication China will be in a position to supply her own needs in the way of cotton goods, and as the value of the imported cotton goods is about £30,000,000 per annum a lucrative native industry is being built up, and it occurs to your correspondent that cotton spinning and weaving companies at home might consider establishing mills out here in co-operation with the Chinese and share the possibilities of this lucrative business. Such mills would have the advantage over a purely Chinese-owned mill in the skill and sound business methods introduced by the British side of the arrangement, and at the same time would have the benefit of the part Chinese ownership in securing trade. Such mills would also have the advantage over the purely foreign-owned mills, in that they could be built on cheaper land outside a Concession or Settlement and would invite no anti-foreign criticism from Young China. This is not to say that all purely Chinese mills suffer under disabilities of management, but most of them do, and a combination of those who, like the British cotton spinner, have a hundred years of experience in the business behind them and of those who have the possibilities of trade in their hands, must be conducive of good, even if the concern eventually, after a period of, say, thirty years, becomes by arrangement entirely Chinese owned, because an industry will have been fostered and one prosperous industry fosters other industries and increases trade generally. The vast trade of South America has been built up in this way, and there is no reason why China should not benefit by adopting the same process, and the British machinery manufacturer benefit also by creating in another vast field a market for the sale of his hitherto unrivalled product.

Hong Kong.

All engineers are interested in wind pressures, but those who remain in Great Britain do not experience the difficulties in this subject that must be solved in the tropics. This year, in Hong Kong and South China, we have been particularly fortunate. Here the tropical hurricane is called a "typhoon," the Chinese words meaning "big wind." The Colony of Hong Kong has experienced many warnings during the past summer, and we have felt the effects of typhoons not far distant. We have not yet been hit by a typhoon proper. A few weeks ago one just missed the Colony and struck the port of Swatow, about 150 miles up the coast. The result was a most terrible catastrophe, in which more than 50,000 people lost their lives. The damage done to property was beyond description. All of the Chinese houses were wrecked. It has been proved that if a building with reinforced concrete floors and roofs is erected properly it will stand up against this terrific wind pressure. It is estimated that the wind within the typhoon travels at a speed well over 100 miles per hour, and in this Colony structural engineers and the Government building authorities allow for very abnormal wind pressures. There are people here who remember the 1906 typhoon which passed through the harbour, carrying death and destruction in its wake. About 20,000 people were drowned and large merchant ships were tossed up on to the shore like straws, being subsequently left high and dry. Since that date the Public Works Department has provided typhoon shelters for native crafts. The shelters are formed by running out breakwaters, and they have so far been effective. The only shelter for the big steamers is the harbour, and when the typhoon signals go up the steamers leave the wharves, tie up to the buoys and get up full steam to assist them in their struggles with the elements. Modern science has enabled us to obtain warnings of the approach of typhoons, and from time to time signals are hoisted and everyone in the Colony watches them with anxiety. In the 1906 typhoon the roof of a large hall was swept right away, and in the recent typhoon at Swatow the upper part of the bridge of one of the steamers was carried away by a part of a native roof which had been blown right out to sea. As the Chinese become more and more acquainted with the advantages of steel and reinforced structures they will insist upon having them for dwellings and business premises; also it is to be hoped that the Chinese towns will make arrangements for suitable signals and warnings. A recent typhoon, which was 150 miles distant from the Colony, made itself felt here to such an extent that the reclamation works were affected and some temporary buildings demolished. The wind travelled at 70 miles per hour.

There has been a considerable amount of local excitement concerning the telephone service. In some quarters the idea of the Government taking over the system is favoured. The Government of a Crown Colony, such as Hong Kong, is in rather a different position from a municipality in England, if only because it can make its own laws. The Public Works Department is the biggest spending department of the Government, and has a large staff of British engineers. Beyond roadmaking it has not had much to do with communications.

In connection with communications it may be mentioned that everyone in Hong Kong is most disappointed at the delay in making this place a station for the Imperial wireless chain. For the last ten years we have talked and talked about wireless, but although the Admiralty has a powerful station, commercial firms have to rely almost entirely upon cables. It is satisfactory to record a decided improvement in the cable service. During the last few months the northern route *viâ* Amoy, Shanghai and Siberia has been opened and working fairly well, an indication that the Russians are making efforts to open up their country again. It is of interest to note that it is rather more than fifty years ago that the first cable message was received at Hong Kong. The line from Singapore was laid in 1871. A message from Hong Kong went to Singapore and on to England *viâ* the Cape. The next cable connection to this Colony was with Manila in 1880. It was not until 1883 that Hong Kong and Shanghai were connected by cable. It cannot be denied that during the last eight years there has been great local inconvenience owing to cable delays, and contracts have been lost to British firms in consequence. It is to be hoped most sincerely that Hong Kong will soon have a powerful wireless station. Meantime the adjoining province of Kwangtung has been importing wireless sets from America, probably to be used for the local military operations.

Electrical Progress in Canada and the United States.

AT the opening meeting of the Liverpool Sub-section of the Institution of Electrical Engineers, the chairman for the current year, Mr. B. Welbourn, delivered an address on the electrical progress which has been made in Canada and the United States during the past fifteen years. The lecture was based on observations made during a visit to those parts, and much instructive information was given concerning growth of the telephone systems and that of general electrical engineering. In Chicago there is, it appears, one telephone to every five people, whilst in Los Angeles, California, there is one telephone to every four people. The lecturer also dealt with the progress of long-distance telephony, but as this was covered pretty fully in Mr. Gill's presidential address before the Institution in London, we will pass on to what the lecturer had to say about broadcasting. It is estimated that there are about 2,000,000 wireless telephone sets in the United States, but the manufacturers now appear to have outgrown the demand, and makers of sets are now said to be loaded with unsaleable stock. Whether this is due to seasonal slackness of demand or to a dying interest in wireless telephony remains to be seen.

As regards electricity supply the New York Edison Company alone has 600,000 kilowatts of plant installed, whilst the Commonwealth Edison Company has 626,450 kilowatts of plant, of which 230,000 kilowatts is in the Fisk-street station. In December of 1921 the maximum demand in that city was well over 500,000 kilowatts. The total kilowatt-hours developed by the company in 1921 were 1,928,271,940, or 714 kilowatt-hours per head of population. The number of new consumers added in 1921 alone was 62,287. Figures brought forward relative to the

LARGE ELECTRIC TRANSFORMERS

THE METROPOLITAN-VICKERS ELECTRICAL COMPANY, LIMITED, TRAFFORD PARK, MANCHESTER, ENGINEERS

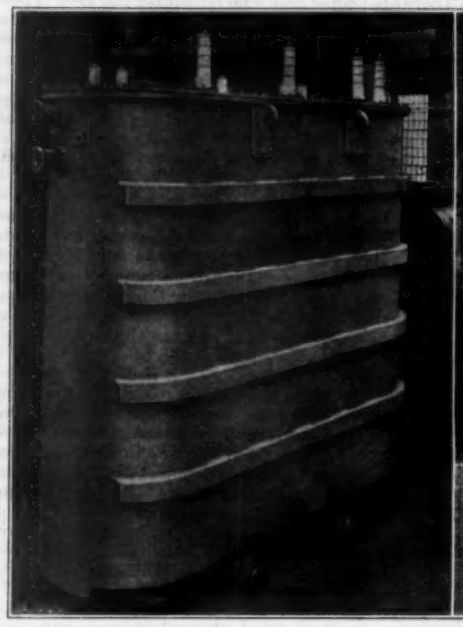
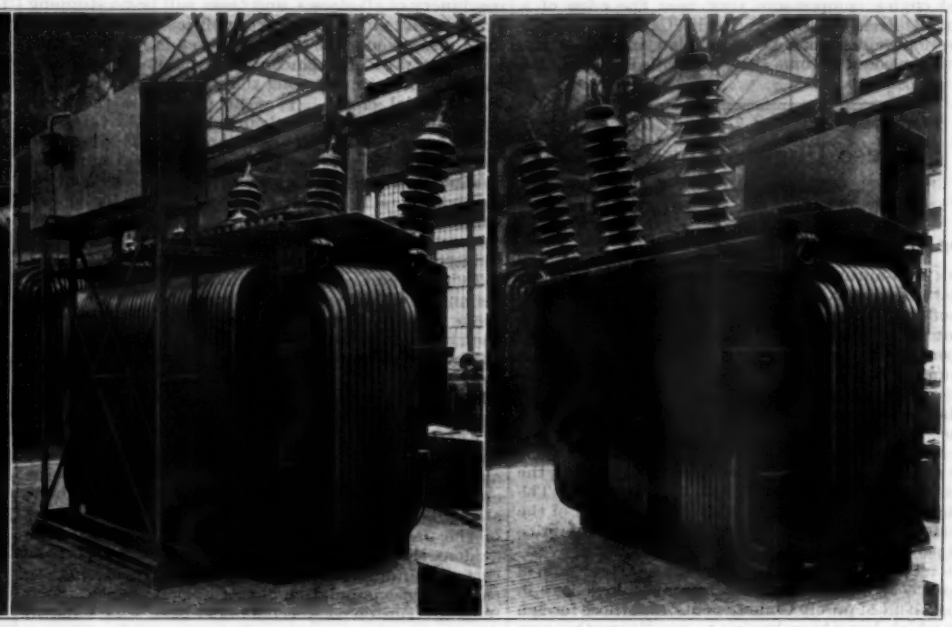


FIG. 1—19,500-K.V.A. TRANSFORMER FOR BOLTON



FIGS. 2 AND 3—1000-K.V.A. 88,000/11,000-VOLT TRANSFORMERS FOR TASMANIA

use of electricity in this country showed that an immense amount of leeway has to be made up in the capital city of our country alone before the use of electricity reaches the state of development attained in America. In considering the question of how such a great amount of electrical business is done in the United States and Canada, the lecturer expressed the opinion that it is a habit with most people in those places to use electricity. It was to be remembered, he said, that the States and Canada were largely new countries where gas had not become entrenched when electric lighting first became available, and that the growth of most of the cities had been coincident with the electric era. In many places both gas and electrical interests were under the control of one company with men at the top who had encouraged the use of gas for heating and advocated the employment of electricity for lighting and power.

The advent of electric light into the home has been followed up by very active propaganda by salesmen of electrical accessories such as irons, radiators, cookers, and so forth. The electricity supply companies also have extensive showrooms in which prospective customers can see apparatus, domestic and other appliances in actual use before purchasing them. In Chicago, for instance, the whole of the ground floor of the Edison Company's large building is used as showrooms. Most of the street, tube and high-speed inter-urban railways are run electrically, but much larger traction loads will be dealt with when the electrification of main lines is undertaken on a large scale. Immense loads are provided by the express lift systems, which are used in every important office building. At night, the lecturer explained, large quantities of power are used by the electrical advertising signs, and anyone who has seen the "White Way" in New York is not likely to forget it. In spite of the large power loads, the lighting pressure is remarkably steady.

Hitherto American engineers have had to confine their attention mainly to the development of high-pressure transmission lines, and cables have been of minor importance; but in consequence of the large loads that now have to be transmitted and the attitude which the fire insurances have adopted in respect of the use of overhead wires, engineers in America are now compelled to give more attention to the construction of three-core high-voltage cables. Long-distance transmission lines are, however, a conspicuous feature of the electricity supply business in the United States and Canada. Because of the absence, in some places, of coal and oil electricity must of necessity be transmitted over long distances by means of overhead lines, notwithstanding their susceptibility to trouble as the result of lightning and storms. These troubles are very pronounced in the Eastern and Middle West States, but on the Pacific coast, where there is a notable absence of lightning and snow, higher voltages are permissible than elsewhere.

The Great Western Power Company in California is successfully working its system at a pressure of 165,000 volts, whilst the Southern California Edison Company will bring into use next year a 240-mile reconstructed line working at a pressure of 220,000 volts. A great deal of the success or otherwise of these transmission lines, the lecturer stated, depends on the suspension type insulators. Up to about five years ago these insulators were very unreliable, but the manufacturers in the States and Canada and one manufacturer in this country have now developed insulators of this type which can be depended upon.

As regards railway electrification, Mr. Welbourn explained that there is but one real example of main electrification in the States. Important work had, he said, been done on the New York, New Haven and Hartford and the Norfolk and Western and Pennsylvania systems, on which 11,000-volt single-phase current was used, whereas on the Milwaukee line 3000-volt direct current was employed. The question as to whether railways should be worked with direct or alternating current was one which had given rise to a good deal of controversy, but so far as could be seen there was no sign of either system being adopted exclusively in the United States.

Modern Transformers.

DURING a recent visit to the works of the Metropolitan-Vickers Electrical Company, of Trafford Park, Manchester, we had an opportunity of inspecting some exceptionally interesting transformers. Among others, there were six 19,500 kilovolt-ampère three-phase units destined for the Barton station of the Manchester Corporation, which are said to be the largest that have so far been built in Great Britain. They are designed for a periodicity of 50 cycles per second, and have a ratio of 33,000 to 6600 volts. One of the units complete is shown in Fig. 1, whilst Fig. 4 shows the iron core with the top yoke removed. Complete with the case and oil, which cools the windings in accordance with the forced circulation system, each unit weighs 59 tons. The overall length in each instance is 14ft., the breadth 6ft. 5in., and the height 15ft. 7in.

On account of the great weight of these transformers they have been constructed so that each leg of the core and the corresponding windings can be handled as a single piece, the windings of each leg being assembled together and held between two substantial steel castings, and in order to take up any slight shrinkage the Metropolitan-Vickers Electrical Company's spring dashpots, which we have previously described, are fitted to the inside coils. The joints between the ends of the vertical cores and the top and bottom yokes are of the butt type. A notable feature of these transformers is that the tanks, which are composed of boiler iron, have been made exceptionally strong in order that the windings may be dried out under vacuum preparatory to their being put into commission. To facilitate the handling of these large and heavy units rollers have been fitted, as shown in Fig. 1.

Some 1000 kilovolt-ampère transformers were also under construction at the time of our visit for the Tasmanian Hydro-electric Department. These are also three-phase 50-cycle units, but the voltage ratio is 88,000/11,000 volts, and the windings are star-delta connected. Two views of one of these transformers are given in Figs. 2 and 3. As in the case of the Barton transformers, the core type of construction has been adopted, and the windings are immersed in oil, but the oil is cooled by natural radiation from the tanks, which, as shown in the illustrations Figs. 2 and 3, are fitted with external tubes. The length of each of these transformers is 11ft. 7in., the breadth 8ft. 10in., and the height 12ft. Including the oil, the weight of each of these transformers is 19 tons. The top and bottom yokes of the cores are interleaved with the vertical limbs. These transformers are also fitted with the makers' patented spring and dashpot coil supports, which, in addition to compensating for any slight shrinkage of the coils, also prevent the coils being damaged by short-circuits. High-tension terminals of the condenser type, as shown in Fig. 2 and 3, are used for insulating the lead-in high-tension conductors, the porcelain parts being of the petticoat form, to make the insulators serve satisfactorily outdoors. The tank is also fitted with a weatherproof cover, and in order to minimise the dangers of moisture being absorbed from the air and sludge being formed in the oil, an oil conservator is mounted by the side of the tank.

This conservator is provided with a calcium chloride breather through which the air has to pass, thus further reducing the possibility of any moisture being absorbed by the oil. The oil conservator, with its calcium chloride breather, is shown in Fig. 2, which gives a view of the transformer from the low-tension side, whilst Fig. 3 shows the high-tension side. Under the insulation test this transformer was subjected to a pressure of 220,000 volts for one minute

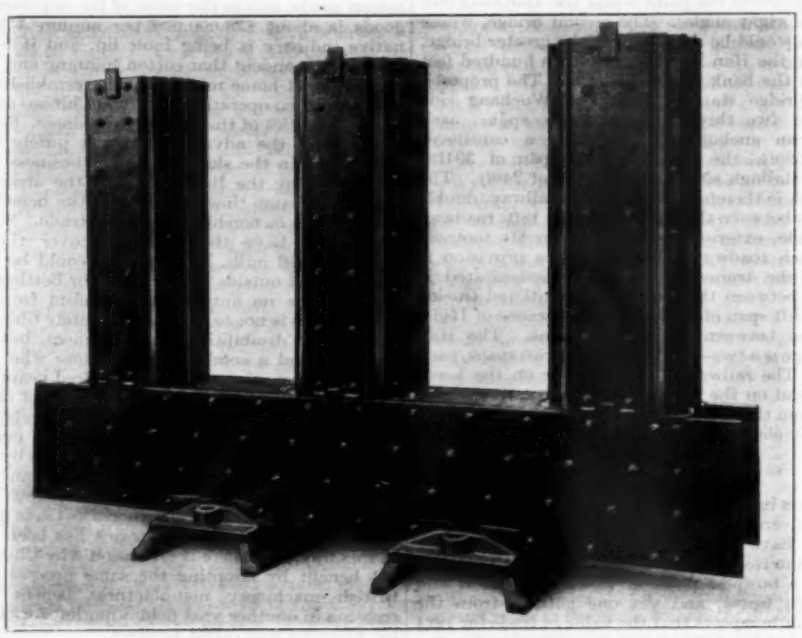
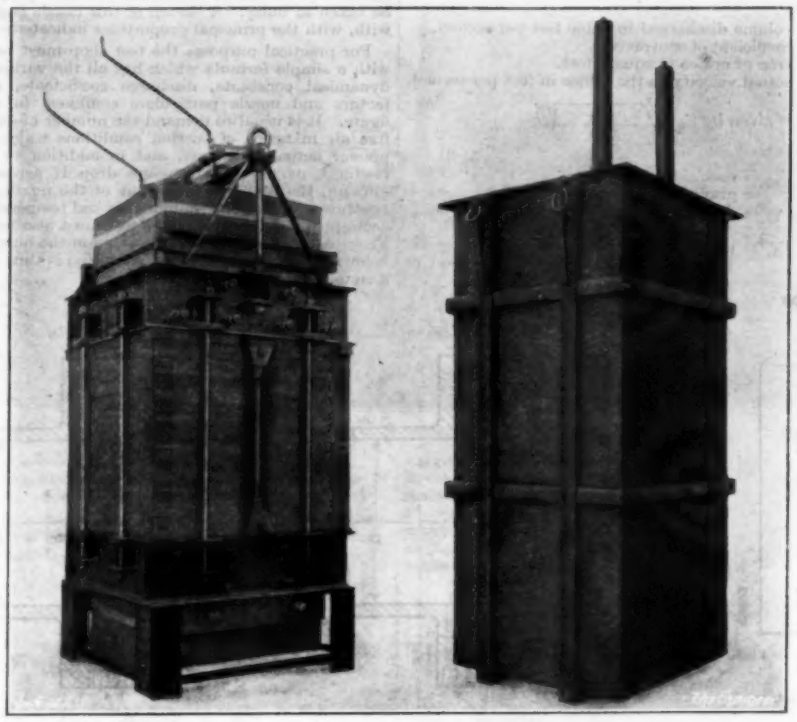


FIG. 4—CORE OF 19,500-K.V.A. TRANSFORMER WITH TOP YOKE REMOVED

A transformer which differs considerably from those which have been described, in respect both of construction and working voltage, is shown in Figs. 5 and 6, which illustrate a 2500-kilovolt-ampère single-phase 50-period 133,000/11,000 transformer. This transformer has been designed for testing purposes, but it is obvious that three similar units might form a star-delta connected group with a capacity of 7500 kilovolt-ampères. It will be seen that in this case the shell form of construction has been adopted, and cooling is carried out on the forced circulation system. The core is built up of laminations composed of a special non-ageing steel, and the laminated parts are arranged in the form of two hollow rectangles, which are clamped between two heavy end frames by means of long



FIGS. 5 AND 6—2500-K.V.A. 133,000/11,000-VOLT TESTING TRANSFORMER AND CASING

tie bolts. The windings are of the sandwich type, and the coils are arranged in groups with insulation and oil ducts between them. They are rectangular in shape, and are built up and supported so that every turn is held rigidly in place. Strong adjustable coil supports take up any possible shrinkage of the insulation, and as these supports are mounted at the bottom of the frame and take the weight of the coils and insulation, the possibility of the coils resting on the core laminations is prevented.

Bilbao Iron Ore Market.

LONG discussions have taken place at Bilbao concerning the situation of the iron ore market. It appears that there are over 2,000,000 tons of ore in the mining depots, and that exports during the first eight months of 1922 amounted to only about 1,500,000 tons as compared with nearly three times that quantity in normal circumstances.

Some say that the only method of surmounting the crisis and regaining the British and German markets is to reduce wages, but others point out that would hardly be possible seeing that the difference between the price of the Bilbao ore and that of ore from the Mediterranean coast, Morocco and Algeria, amounts to 3 pesetas at least, and that labour's share could not be reduced in those proportions. The workers, they declare, must agree to bring their production up to the pre-war level, but that solution does not seem capable of early realisation, for the men, with some exceptions, still hold to the theory of the least possible effort, and there are those among them claim that too much work is being done already, since there are 15,000 men unemployed who would obtain work if individual production were less. In view of the prevalence of such ideas, there are chances that the price of Bilbao iron ore will long remain above that of competing ores. It is evident also that some people, mineowners included, do not yet fully realise that foreigners can buy their ore in other parts besides Bilbao, but the two parties must sooner or later understand, in order to avoid ruin, that they must agree to moderate their demands and arrive at cost prices which will be within the reach of buyers.

Electrical Developments in Venezuela.

IN view of the success attending the development, by means of foreign capital, of oil and asphalt concessions in Venezuela, combined with the re-advent to presidential power (for a third period, 1922–1929) of General Juan Vicente Gomez, a marked disposition has manifested itself among certain institutions and individuals to finance industrial enterprise in the republic. Chief attention will be given to the exploitation of long dormant hydro-electric possibilities, only the fringe of which has hitherto been touched, although abundant opportunities in that direction are believed to exist. Venezuela is traversed by no fewer than 1059 rivers and streams; and a considerable number of the affluents to such rivers as the Orinoco, Apure, Meta, Caura, Negro Guarico, in addition to several waterfalls, could, it is stated, be successfully adapted for the supply of hydraulic power. On the American continent the Amazon and Mississippi alone excel the Orinoco in importance.

Of the electric plants already established in Venezuela fewer than six are hydraulically operated, among them being a plant at El Encantado, 16 kiloms. from Carácas, an enterprise first organised in 1897 and subsequently enlarged. In it most of the machinery is of Swiss origin, while the cables and wires are of Italian manufacture. Power is used for operating corn mills, coffee mills, printing offices and for lighting the city of Carácas, but it is thought that the employment of current can be largely extended in the latter direction.

Arc lamps of 2000 candle-power are used in the streets, and a large quantity of incandescent lamps of 40 and 60-watt capacity for private houses is annually disposed of, both the ordinary metallic filament lamps and the gas-filled types being employed, and it is considered that there should be a broadening market for high-power gas-filled lamps for park (plaza) and street lighting. Markets for these and other lines of electrical supplies are to be found at Mérida (Mérida State) where the available horse-power is at present very little utilised, and the machinery hitherto installed is on the direct-current system; at San Cristóbal (Táchira State), where a few of the city and industrial concerns alone now use power; and at Maracaibo, Valencia and Puerto Cabello, at all of which towns, as well as part of the capital (Carácas), the electric plants have steam as motive power. Considerable development is possible at Naiguata, 20 kiloms. (12.43 miles) from Carácas, where there is an available head of some 1026 m. (3366ft.) with a volume of 515 litres (18.18 cubic feet) per second, and a rated effective horse-power of 4300. It is claimed that this source of power with slight additional cost might be made to deliver 6000 horse-power.

Some time back a concession was granted to an engineer (Dr. Luis Monoz Tebar, of the Escuéla de Artes y Oficios at Caracas), to construct an electric plant 1 kilom. from the sea, where it will be possible to erect a small port to unload the hydraulic machinery, the penstock and other materials for the work. The concession covers the right to supply in the capital, power for cooking for various industries and for the railways between the port of La Guiara and Carácas and between Carácas and Los Teques, as well as for distant properties in the districts of Petare, Ocumare and Santa Lucia. It is also proposed to use a waterfall on the Manzanares River to work the railway from Oumana to Oumanacoa. This line is of 1.07 m. gauge (3.51ft.) and 60 kiloms. (37.28 miles) in length. Foreign capitalists exploiting this enterprise and similar undertakings would probably enjoy exemption from local, State and Government taxes.

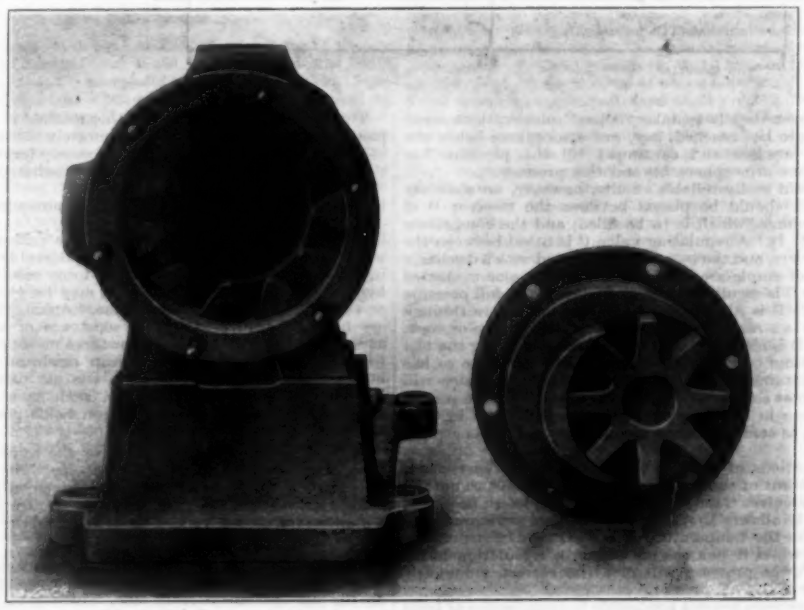
A New Rotary Pump.

A ROTARY pump, which appears to us to have several valuable features, that has just been brought out by J. Stone and Co., Limited, of Deptford, London, S.E.14, is illustrated in the accompanying engraving.

It is really a development of the ordinary gear pump, such as is used for many small lubricating jobs, or where comparatively small quantities of liquid have to be dealt with. Instead of the usual arrangement of two plain gear wheels meshing together, the new pump comprises one wheel with external, and another with internal teeth, and in this way a much more compact arrangement is obtained.

In the illustration the pump is shown taken apart. On the left there is the casing with the internally toothed wheel in place. The teeth extend axially from the face of a disc, which is overhung on the end of the driving shaft, that passes through a stuffing-box in the back of the casing. The teeth make a very good rubbing contact with the casing, and are also fitted carefully to match those of the idle wheel shown on the right. The latter wheel runs on a stud, fixed in the cover, which is drilled for lubrication. A crescent-shaped piece is cast on the cover to fill the space between the tops of the teeth on the two wheels. It will be readily appreciated that the spaces between the teeth of both wheels will be filled with fluid from the suction branch, seen on the extreme left, and, after being carried round the crescent, will be expelled at the discharge above; while the intermeshing of the teeth during the remainder of the cycle will prevent any back flow from the discharge to the suction.

We recently saw one of these little pumps at work pumping heavy fuel oil, and it was noteworthy that it would pick up against a suction head of several feet. It is, of course, probable that it would not start against so great a suction head, without priming, when lifting water, but we were assured that the difference is not appreciable. As soon as the pump was delivering we throttled down the suction to represent about 28ft. of water, and restricted the delivery until the pressure rose to nearly 75 lb. per square inch, without reducing the quantity of oil delivered to any noticeable extent. The pump in question was a nominal 1¼in. size, that is to say, it had a delivery 1¼in. in diameter, and delivered 50 gallons per minute when running at 400 revolutions per minute.



THE STONE ROTARY PUMP

The efficiency in these circumstances was said to be 60 per cent., and although a slight amount of rattling was produced when the pump was working against the maximum head, it was quite quiet at normal loads.

The pump is being made in several standard sizes, ranging from ¼in. to 3in. delivery, arranged for belt driving or direct coupling to a motor.

Testing Air Compressors.*

By WILLIAM REAVELL, of Ipswich, Member of Council.

With the rapidly growing use of compressed air for so many purposes, it is highly desirable that some standard form should be adopted by which the efficiency of compressors can be ascertained, alike for the protection of the user and for the development of the art. "Efficiency" is a term sometimes used loosely, and the technical Press still occasionally contains examples of so-called "efficiency tests," which fail to correct the volume of delivered air for the high temperatures reached while compressing, or which ascertain the volume by calculation from the indicator card, or fail to give the figures for "overall efficiency."

No test should be regarded as complete which fails to give :—

(*a*) The net horse-power applied at the compressor shaft.

(*b*) The volume of air actually delivered, expressed in terms of free air, that is, air expanded down to the atmospheric pressure.

(*c*) The corrected volume by reducing it to the equivalent volume when cooled down to the same temperature as that of the air aspired.

For small machines the "receiver" method of testing is frequently used, and the time taken to pump up an air receiver of known capacity to the required delivery pressure is noted. Such a method is inaccurate, because the real conditions under which the compressor is subsequently to work are not reached until at the instant when the final pressure is attained and the test stopped. A more correct way is to take "time" observations when the pressure has reached, say, one atmosphere below the required pressure and continued till the pressure has reached one atmosphere beyond this pressure.

To obtain really reliable results, however, an auxiliary receiver A should be placed between the receiver B of known volume, which is to be filled, and the compressor (as in Fig. 1). A regulating valve C is fitted between the two receivers, and the test receiver is fitted with a discharge valve D of ample area. When the compressor is started the valve C is regulated so as to maintain the full pressure in A while B is discharging freely to atmosphere through D, which is a rapid action lever type sluice valve or cock. If, then, D is closed at the instant of commencing the test and the time taken to fill B to the same pressure as has been maintained in A, the compressor performance will have been at constant pressure. It only remains to correct the volume in the receiver B for the difference in temperature, as compared with the temperature of the aspired air.

Observations of the exact temperature in the receiver at the instant of completion of test are difficult to obtain, but if the valves C and D are tight when closed, the air in B should be allowed to remain while its pressure is gradually reduced as the temperature falls. If, then, the pressure is noted when it has ceased falling, a calculation based on this lower pressure will give the correct volumetric efficiency of the compressor.

Receiver tests are not applicable to compressors of large volume, and diaphragm or nozzle tests must then be resorted to. Where the machine to be tested is of the reciprocating type, it is advisable to put at the end of the discharge pipe from the compressor an air receiver of sufficient capacity to damp out pulsations. The resistance against which the compressor works is effected by a control valve placed between the compressor and receiver. A thin plate is fixed to the outlet of the receiver, and has a circular hole through which the air escapes to the atmosphere. A slight pressure difference will then be set up between the receiver and the atmosphere which will remain constant as soon as a state of equilibrium is reached.

* The Institution of Mechanical Engineers.

Fig. 1.

Receiver Tests. Arrangement of Main and Auxiliary Receivers and Valves.

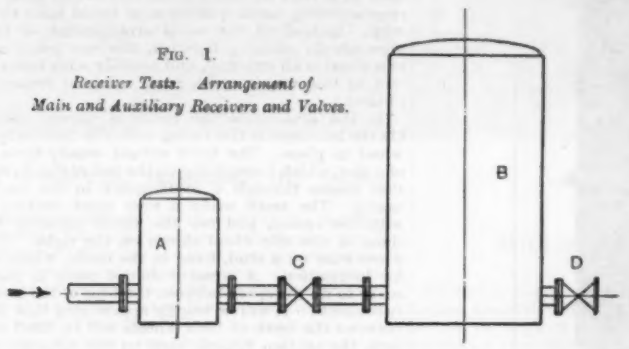
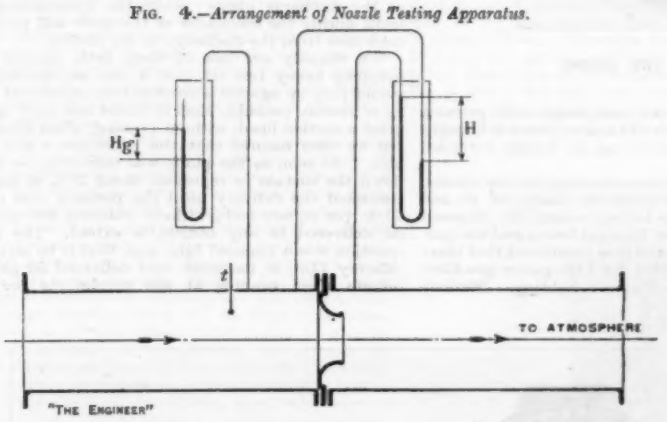


Fig. 4.—*Arrangement of Nozzle Testing Apparatus.*



This pressure difference furnishes a means of calculating the volume of air delivered. The equation for the air flow should be based on the adiabatic expansion of air. This, however, as is well known, involves the use of exponential equations and complicates the work thrown on the staff in the average test house. If, therefore, an orifice is adopted which is sufficiently large to give but a slight pressure difference, the ordinary hydraulic formula can be applied, seeing that the actual change in the density of the gas would be negligible. For example, a pressure drop of as much as 12in. will only give an error of 1 per cent. in velocity when applying this formula. It is the author's practice to use orifices or nozzles of sufficient diameter to keep the pressure drop below this figure. In the hydraulic formula we have

$$V = C_1 A u.$$

Where

V = volume discharged in cubic feet per second.
C_1 = coefficient of contraction.
A = area of orifice in square feet.
u = actual velocity in the orifice in feet per second.

u is given by $C_2 \sqrt{\frac{2g(P_1 - P_2)}{w}}$

Where

C_2 = coefficient of velocity.
g = gravitational constant = 32.2.
w = density of air or gas in pounds per cubic foot.
$P_1 - P_2$ = pressure difference in pounds per square foot = $5.18 \times h$, where h = head of water gauge in inches.

There are two drawbacks to this method ; in the first place, it is difficult to ascertain accurately the temperature of the air in the receiver, which is necessary for determining the specific weight w ; secondly, the discharge coefficient is not constant, but varies with the pressure ratio $\frac{P_2}{P_1}$; it is also affected by the thickness of the orifice plate. A reference to text-books will reveal considerable divergence in the value of the coefficient C, and any results obtained by the adoption of a certain value may be $\pm$ 5 per cent., or even more, from the true value. Again, the readings are frequently affected by the existence of air currents across the face of the orifice. For these reasons it is better to make use of the pressure drop produced artificially in the pipe line through which the air passes by the insertion of a definite resistance, such as a diaphragm or nozzle, and this recommendation holds good whether a receiver is used or not.

If the machine being tested is of the rotary or turbo type, obviously a receiver is not necessary. The diaphragm is usually a thin metal disc, held conveniently between flanges on the delivery pipe, as in Fig. 2. In place of this a rounded nozzle is favoured in modern practice, this being arranged as in Fig. 3.

Fig. 4 shows the arrangement for measuring the temperature and pressure. Pressure connections are arranged on the up and downstream side, which lead to the two legs of a U tube, usually filled with water. It is advisable to keep the pressure drop reasonably low, say below 20in. w.g., in which case the specific weight at the restriction may be taken to be the same as on the upstream side. Only three readings require to be taken, namely, the pressure drop h across the diaphragm or nozzle ; the pressure p in front of the nozzle, and the temperature t. The two latter values are required to determine the density of the air immediately in front of the restriction.

The formula is the same as given above, but here again it is known that the coefficient of discharge of a diaphragm is a variable quantity, dependent on the conditions. It is important, therefore, in comparing different machines under test, to keep a fairly constant pressure drop. The coefficient depends also upon the ratio $\frac{d}{D}$ and upon $\frac{t}{D}$, t being the thickness of the diaphragm disc. For these reasons one cannot assume a value for the discharge coefficient which is applicable to all cases ; a diaphragm of this type should be calibrated by careful laboratory methods under conditions similar to those for which it will be used.

Fig. 2.—*Diaphragm.*

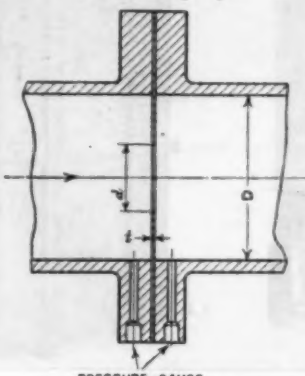


Fig. 3.—*Nozzle.*

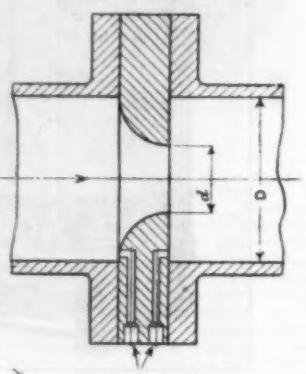
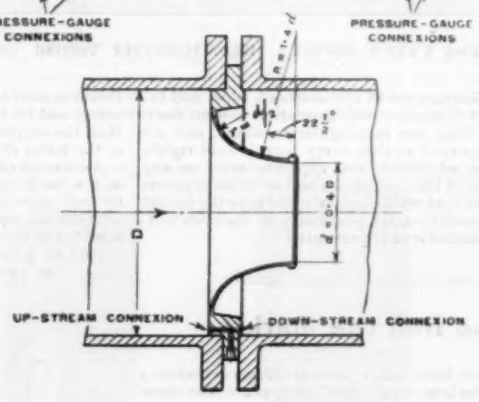


Fig. 5.

German Standard Nozzle.



Rounded Nozzle.—The rounded nozzle—Fig. 3—is more expensive to produce, especially when required for large volumes, but it has the great advantage that its coefficient of discharge is practically constant, and is very close to unity ; a well-designed nozzle has a coefficient between 0.98 and unity ; indeed, the nozzle as recommended by the Verein Deutscher Ingenieure possesses a coefficient of about 0.99 to 0.997, which, for practical purposes, may be taken as unity. A sketch of this nozzle is given herewith, with the principal proportions indicated—Fig. 5.

For practical purposes the test shop must be provided with a simple formula which has all the various thermodynamical constants, discharge coefficients, conversion factors and nozzle particulars combined in one single figure. It is usual to demand the number of cubic feet of free air in terms of suction conditions which the compressor actually delivers, and in addition to the three readings, namely, the pressure drop H across the diaphragm, the pressure p in front of the nozzle, the temperature t, the barometric pressure and temperature of the atmosphere at the time of the test must also be observed. These values are then to be inserted in the nozzle formula below, and the mathematical operation is thus reduced to a simple slide rule problem.

Nozzle formula based on the hydraulic formula using the German standard nozzle :—

$$V_a = 15.8 \times A \times \frac{(t_a + 460)}{Bar} \times \sqrt{H \times \frac{(Bar + Hg)}{(t + 460)}}$$

(cubic feet per second).

This formula will give results within + or − 1 per cent. of the true value, if the pressure drop H is not more than 12in. w.g., when discharging to atmosphere.

The steps by which this formula is arrived at are as follow :—

The discharge velocity, that is, the velocity at the throat of the nozzle is

$$u = \sqrt{2gh} \text{ (feet per second)},$$

h being the head of the gas in feet corresponding to the pressure drop across the nozzle.

Now $h = (P_1 - P_2) \times v$.

Where

P_1 = absolute pressure before nozzle.
P_2 = absolute pressure behind nozzle. Both expressed in pounds per square foot.
v = specific volume of air in front of nozzle, cubic feet per pound.

v can be calculated from the general gas equation, $Pv = RT$, in which

P = absolute pressure before nozzle = P_1.
T = absolute temperature before nozzle = (t + 460 deg.) degrees Fahrenheit.
R = the gas constant = 52.2 for air.

Hence

$$v = \frac{R\,T}{P_1}$$ and by substitution we get

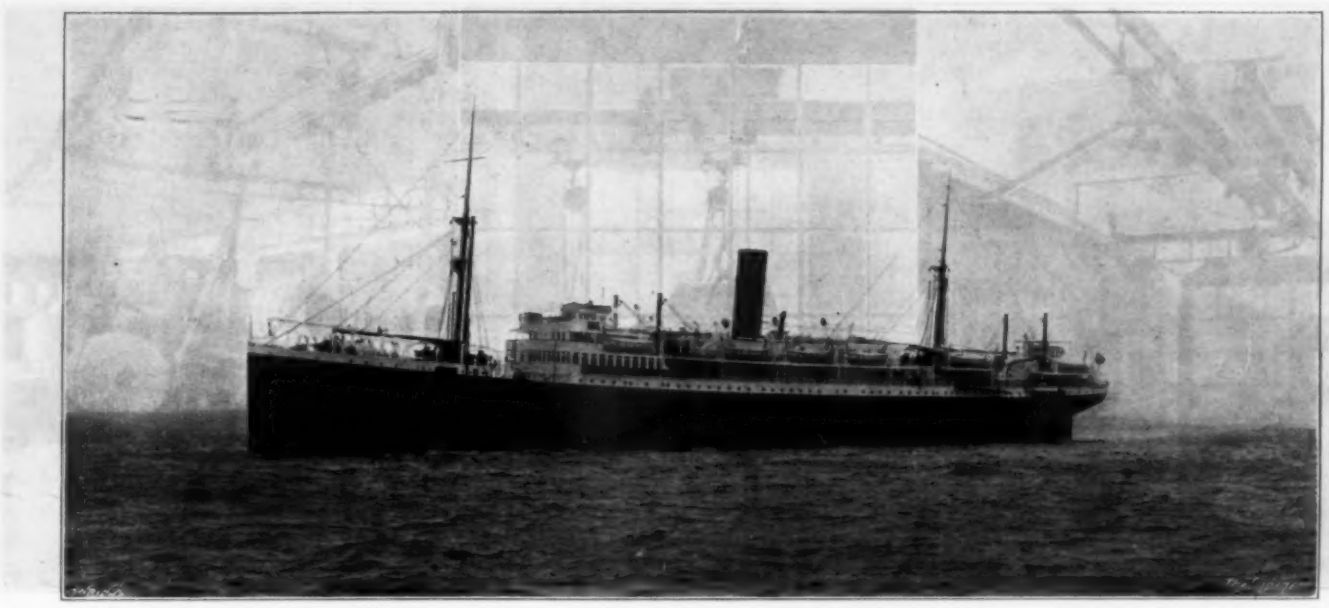
$$u = \sqrt{2g(P_1 - P_2)\frac{R\,T}{P_1}} \text{ (feet per second)}.$$

The discharged volume in terms of the entrance conditions P_1 and T is—

$$V_a = C \times u \times A \text{ (cubic feet per second)}.$$

TWIN-SCREW MOTOR LINER ADDA

HARLAND AND WOLFF, LIMITED, GREENOCK, BUILDERS AND ENGINEERS



where A = area of nozzle throat in square feet.
C = a discharge coefficient which for this type of nozzle may be taken as unity.

Usually it is desirable to express the discharge volume in terms of free air; that is, suction conditions, the corresponding absolute pressure being P_s and temperature T_s. Thus

$$V_s = V_a \times \frac{P_1}{P_s} \times \frac{T_s}{T}.$$

$$= A \times \sqrt{2\,g\,(P_1 - P_2)\,\frac{R\,T}{P_1}} \times \frac{P_1}{P_s} \times \frac{T_s}{T}$$

$$= A \times \frac{T_s}{P_s} \times \sqrt{2\,g\,\frac{R\,P_1}{T}\,(P_1 - P_2)} \text{ (cubic feet per second).}$$

Actually the pressure drop $(P_1 - P_2)$ is measured by means of a water gauge, the reading H—see Fig. 4—being expressed in inches. This value must be converted into pounds per square foot, thus

$$P_1 - P_2 = H \times 0.036 \times 144 = 5.18\,H$$

Again the absolute pressure P_1 is the sum of the barometric pressure (Bar) plus the pressure (Hg) as read off the mercury gauge in inches, which involves the following conversion

$$P_s = (Bar + Hg) \times 0.49 \times 144 = 70.5\,(Bar + Hg).$$

Similarly $P_s = 70.5 \times (Bar)$, 0.036 and 0.49 being the weight of 1 cubic inch of water and mercury respectively. By substitution we get an expression for the volume of air discharged in terms of free air (suction) conditions thus

$$V_s = A \times \frac{(t_s + 460)}{70.5 \times (Bar)} \times$$

$$\sqrt{\frac{2 \times 32.2 \times 53.2 \times 70.5 \times (Bar + Hg) \times 5.18\,H}{(t + 460)}}$$

$$= 15.8 \times A \times \frac{(t_s + 460)}{Bar} \times \sqrt{H \times \frac{(Bar + Hg)}{(t + 460)}}$$

(cubic feet per second).

If it is accepted that the risks of error, due to assumptions from the published tables of the coefficient of contraction and coefficient of velocity, are less with the rounded nozzle than with the diaphragm, and still less with the German standard nozzle than with the rounded nozzle, the same general objection can be raised to all of them, namely, that any results based on them depend on the accuracy of the assumed coefficients. It was for this reason that in Germany, just prior to the war, attempts were made to determine a form of nozzle contour which would have a sensibly constant discharge coefficient in the neighbourhood of unity, and which, with reasonable accuracy, remained of the same value for all geometrically similar nozzles. The nozzle shown in Fig. 5 is the outcome of these experiments.

Another investigator, Dr.-Eng. J. Brandis, of Aachen, examined the hydraulic formula for use with diaphragms and established certain rules for the design of suitable diaphragms which, in conjunction with his formulæ, gave very reliable results. For any one interested full particulars will be found in his book on "Messung Von Gasmengen," published by M. Krayn, Berlin, 1913.

Reference should also be made to the most recent investigations on this subject by the Physikalisch Technische Reichsanstalt in Berlin, an institution equivalent to the National Physical Laboratory. These investigations are based upon Reynold's Law of Similarity and its application to the pressure drop in a smooth tube by means of which it is sought to establish an accurate method for measuring the volume of the fluid passing through the tube. A summary of these investigations has been published recently in the *Zeitschrift des Vereines Deutscher Ingenieure* (February 25th, 1922), and the accuracy of the results obtained, both with air and water, appears highly satisfactory, the mean error between the measured and the calculated values being about $^3/_{10}$ per cent.

This problem of more accurately determining the measurement of volume of air and other gases under varying conditions is receiving the attention of scientists in other countries, and it is hoped that the time is not far distant when investigations will be made by the National Physical Laboratory, or some equally reliable Institution, which will place the British engineer in the same position as that arrived at by German users as a result of the tests made in that country.

The Elder Dempster Motor Liner Adda.

THE twin-screw motor liner Adda, which left Liverpool on Wednesday last on her maiden voyage to West Africa, marks an important addition to the Elder Dempster fleet. Although of moderate tonnage—gross tonnage about 7800 tons—the new vessel is without doubt, both with regard to design and equipment, the leading example of a motor ship specially built for passenger carrying. The motor ships of the East Asiatic Company and the Glen Line have always carried a limited number of passengers, and those who have travelled on these ships have learned to appreciate the advantages of the Diesel-engined vessel; but it remained for the Elder Dempster Company to put into service the first motor liner passenger service with the Aba, which was placed on commission on the West African service nearly a year ago. The successful operation of the Aba over this period has enabled the owners and builders to embody in the new ship improvements both in equipment and accommodation.

GENERAL PARTICULARS.

The Adda was launched on May 25th from the Greenock shipyard of Harland and Wolff, Limited, and was built and engined there. Successful trials were run on the Clyde on November 14th, after which the vessel proceeded to Liverpool to prepare for sea. The following are the leading dimensions of the new ship, which, by the courtesy of the owners, we had the pleasure of inspecting before her departure:—Length, 450ft.; breadth, 57ft.; moulded depth to awning deck, 34ft. 6in.; with a gross tonnage of about 7800 tons.

The general appearance of the Adda will be seen from the illustration we reproduce. Classed 100 A1 at Lloyds, she complies with all the requirements for the Board of Trade regulations for motor passenger ships. A double bottom extends right fore and aft, and there are eight water-tight bulkheads up to the awning deck, which divide the vessel into six holds and the motor room. The water-tight doors below the main deck are electrically controlled from the bridge, and in addition are fitted with emergency release gear. In the passenger accommodation above the water-tight bulkheads steel fireproof partitions are fitted with fireproof doors. The fire-fighting appliances are very complete throughout the whole ship, and chemical extinguishers and a "Foamite" installation are included in the equipment, which embodies a system of electrically operated fire alarms. The lifeboat equipment comprises twelve lifeboats and one motor boat, the lifeboats being slung on Welin davits of the semi-rotary type. Among other features we may mention the emergency generating set, which is accommodated at the aft end of the awning deck and is a 100-kilowatt set similar to the main auxiliary units. A separate Heenan and Froude cooler is provided on the upper deck for this engine, which is thus a self-contained unit.

PASSENGER ACCOMMODATION.

We may refer briefly to the passenger accommodation, which is spacious and well appointed and provides for 225 first-class, 74 second-class, and 32 third-class passengers. There are three decks running fore and aft.

The main deck A is principally occupied by the dining, galley and pantry accommodation for both first and second-class passengers, and there are in addition some first-class state-rooms and second and third-class cabins. The first-class dining saloon is provided with small tables, and the arrangements are such that upwards of 200 may dine at one sitting. The second-class saloon is also situated on the main deck, accommodation being provided for 108 diners. The pantry and kitchens are furnished with all the newest electrical cooking and labour-saving appliances.

The awning deck B is chiefly given up to state-room accommodation. In addition to two sets of *en suite* rooms, there is a series of state-rooms arranged on the tandem principle, which allows access to the ship's side from the inner rooms. Individual heating, ventilation and water services is fitted to each cabin. The engineers' staff is housed on the deck amidships on the starboard side and access to the engine-room is obtained from the adjoining working gangway, in which certain controls and recording instruments are placed. At the aft end of this deck a space is reserved as a promenade for the third-class passengers. The combined poop and bridge deck C extend practically along the whole length of the ship, and the large deck-house accommodates a number of state-rooms and the first-class lounge, while behind the deck-house are found the second-class entrance hall and smoke-rooms. The forward part of this deck is enclosed at the front and sides, and vertical sliding windows are fitted to form a closed promenade. The boat deck is over 260ft. in length, and on this deck are situated the commander's and the deck officers' accommodation, the wireless room, the first-class smoking, reading and writing rooms.

DECK MACHINERY.

In addition to the electrically operated and controlled heating and ventilating systems, all auxiliary deck machinery, such as the winches, capstans and steering gear, is electrically driven. Twelve Laurence-Scott 4-ton cargo winches are installed, each winch being designed to deal with 4 to 5-ton loads. These winches are arranged to serve cargo derricks of the channel lattice type, which are arranged for lifting loads up to 10 tons in weight. In all the vessel carries a cargo of about 5000 tons. A special 6-ton warping winch and capstan, by J. H. Wilson, of Birkenhead, also motor driven, the controllers and motors being supplied by Laurence-Scott, was noted.

The Harland and Wolff steering gear operated on the Scott single-motor system of steering gear drive is worthy of mention. It depends on the direct starting and stopping of a specially designed motor geared on to the quadrant, which is effected by means of a relay controller. The telemotor which is used to connect the motion of the distant wheel to the main controller is worked on the Wheatstone bridge principle in such a way that any movement of the wheel is accurately reproduced by the telemotor and transferred through the driving motor to the quadrant and the rudder itself. The wheel house and bridge are fitted with the latest improvements, among which may be mentioned Clay's automatic steering control for preventing the faulty transmission of orders. An installation of pneumatators, by Kelvin, Bottomley and Baird, enables the draught of the ship to be instantly read.

An interesting feature of this ship is the oil reception room, at which oil may be taken in for both the lubricating and oil fuel services and transferred to appropriate storage tanks. A special visible overflow arrangement is provided, so that should any unforeseen stoppage in the pipe lines occur—say, owing to a closed valve—the attention of the attendant is called and waste of oil avoided. The fuel oil is stored in the double bottom and deep tanks, and sufficient is carried to allow the vessel to make the round voyage to West Africa without bunkering. In all, about 850 tons of fuel oil are carried, and if the oil supply arrangements allow this quantity can be taken aboard in about five hours. Several fans for the ventilating installation and the Thermotank heaters are installed on the upper deck. The large fans, by Davidson, of Belfast, driven by Laurence-Scott variable-speed motors, are nineteen in number and vary in diameter from 10in. to 30in. They are arranged for distant control from the fan control room. The mechanical ventilation is supplemented by Verity hand-controlled fans placed in the cabins and public rooms. We shall refer in a subsequent article to the main propelling machinery and main auxiliaries.

THE LOUDEN-KING OVERHEAD RUNWAY SYSTEM

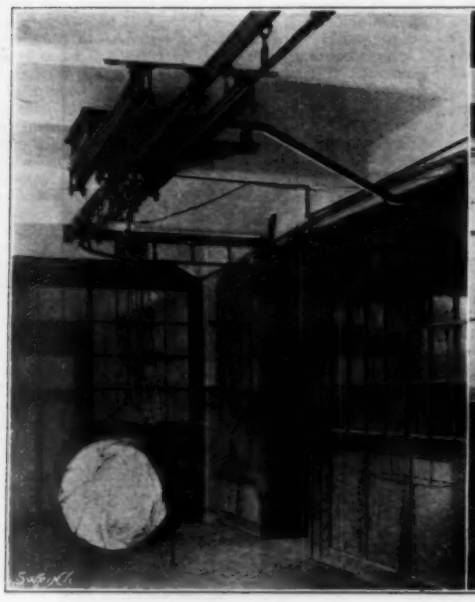


FIG. 1

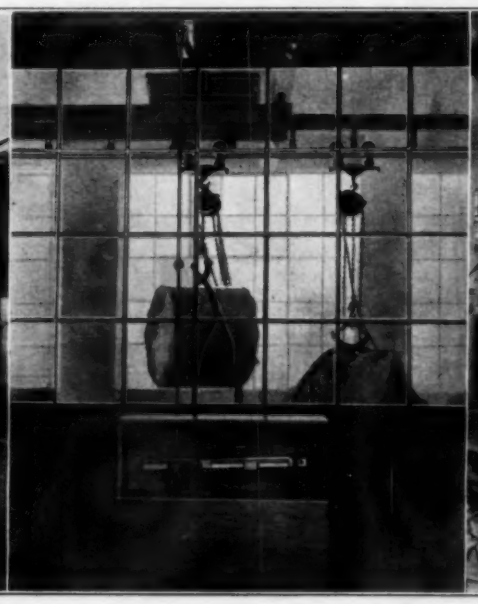


FIG. 2

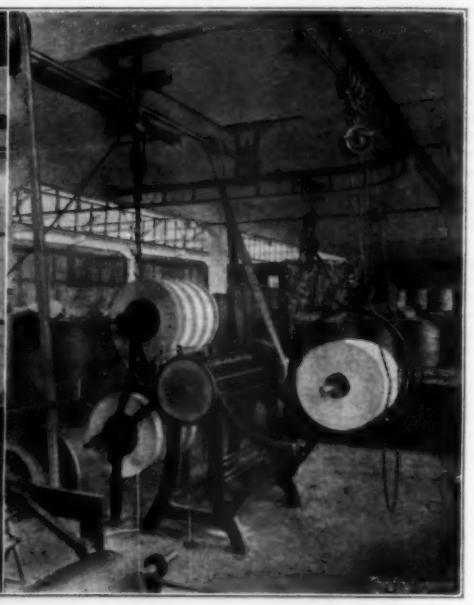


FIG. 3

A Modern Overhead Runway System

At the Letchworth works of the British Tabulating Machine Company, an interesting example of the Louden-King overhead runway system has recently been installed by Geo. W. King, Limited, of Stratford, London. The system is designed to handle the rolls of paper which are received at the works for cutting up into tabulating cards. It is employed to transport the rolls from the point of delivery into the storage department, and thence to the slitting machine, or, it may be, direct to the latter from the point of delivery. In addition, it is designed to handle bags and bales of the waste paper produced in the manufacture of the cards.

In Fig. 1 a view is given of the runway at the point at which it passes out of the delivery department into the storage department. Just before it reaches the bend the carriage passes on to a 14in. length of rail, which is suspended from an overhead weighing machine, the lever of which passes through the adjacent partition, and is coupled to a steelyard in the storage department, as shown in Fig. 2. Thus each incoming roll of paper or outgoing bale or bag of waste can be quickly and accurately weighed while actually on the track. The runway extends down the storage department and then across it, as shown in Fig. 3, to a two-way switch, which permits the roll to be sent either to the slitting machine in the foreground, or into the storage space in the background.

The trolleys have each four wheels, and run on a steel trackway of cruciform section, as shown in Fig. 4. The wheel axles are of steel, ¾in. in diameter, and are held stationary in the body casting. The wheels revolve on tempered steel rollers, $^{3}/_{16}$in. in diameter and 1in. long, of which there are seventeen per wheel. Two of these two-wheeled elements are combined into a trolley by uniting their stirrup portions by a swivel jointed link, from the centre of which depends a swivel jointed hook. A 5 cwt. hoisting block of the Weston or similar type attached to the hook supports the tongs carrying the rolls or bales.

The track is of high carbon steel, and is claimed to be so designed as to eliminate all unnecessary friction. A special feature of the track, distinguishing it from the enclosed or tubular form, is the fact that it can readily be bent cold to any desired form without appliances other than a pair of bending irons or plates attached to a post or other support. Ordinarily if the exact form of a curved portion of a runway is known, the track is bent by Messrs. King in their workshops. In some instances, however, the exact form is not known beforehand, while in others it may be required to alter the runway after installation to suit a rearrangement of the service. In these circumstances the fact that the track can readily be bent on the site forms no doubt a very considerable advantage in its favour. The standard radius for a right-angled bend is 4ft., but other regular bent sections down to a radius of 2ft. 6in. are supplied. The track is suspended, in the case of the Letchworth installation, from 4in. rolled steel joisting attached to the roof principals, or from steel insertions let into the reinforced concrete flooring of the first storey during the erection of the building. To the lower flange of the joisting clamps are attached at regular intervals, and from them the track is suspended by means of hangers, which clip on to the upper bull-head portion of the track. When a join in the track is required, it is effected by applying fish-plates to the lower bull-head portion.

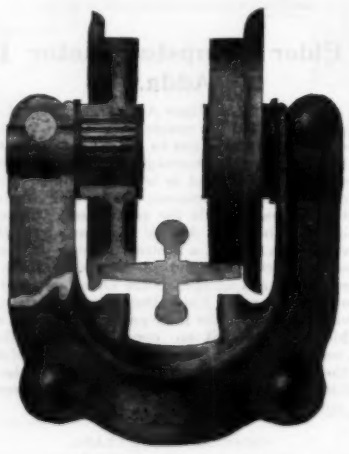


FIG. 4—TROLLEY AND TRACK

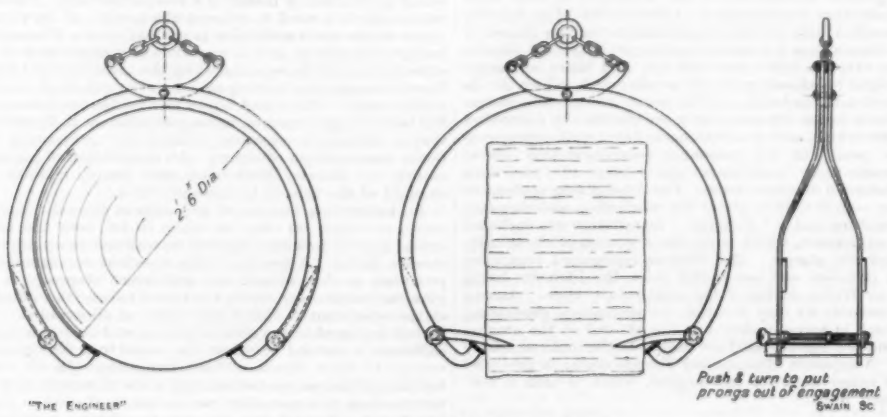


FIG. 5—TONGS FOR ROLLS AND BALES

The tongs have been specially designed to suit the double duty required of them. Each limb is forked, as shown in Fig. 5, and the two points of the fork are united by a flat strip, which, it is claimed, does not result in the rolls lifted being indented. For the purpose of handling the bags or bales of waste paper prongs are provided on the forks, and can be lowered until they rest on the flat strips joining the fork points. When not required, the prongs are held back by projections on the sides of the forks. The use of tongs of this form for handling the rolls of paper instead of lifting them by means of a rod passed through their cores, leaves the ends of the rolls completely free for the insertion of the special axle on which they are carried when in the slitting machine.

Australian Engineering Notes.

Both the Victorian Legislative Assembly and the Legislative Council have passed the Border Railways Bill.

* * * * * *

A Bill authorising the construction of the bridge across Sydney Harbour, connecting Sydney and North Sydney, passed through both Houses of the New South Wales Legislature early in November. The cost is estimated at £5,500,000.

* * * * * *

A company is being floated in Bendigo (Victoria) to establish the wool top industry in that town. It is intended to purchase a complete plant, with a capacity for producing 1,440,000 lb. of wool tops each year. The capital proposed is £150,000, and the factory plant is estimated to cost £50,000. It is suggested that wool growers should be invited to have their wool converted into tops on a commission basis. The provisional directors are Messrs. G. V. Lansell (Bendigo), W. S. Keast, and D. Melvin (Melbourne).

* * * * * *

The Orange Woollen and Knitting Mills, Limited, has been registered at Orange (N.S.W.), with a capital of £25,000. The company will manufacture all classes of knitted goods, hosiery, underwear, &c. The directors are Messrs. S. and S. A. Whitmee, and R. Gavin, Orange.

* * * * * *

In connection with the work of converting the Melbourne suburban railway system from steam to electric traction, the Railway Commissioners anticipate that by the end of February next all of the lines approved by Parliament in 1912 will be electrified, with the exception of the sections between Box Hill and Ringwood, and between Heidelberg and Eltham. The completed scheme will include the erection of the power-house at Newport, with an installed capacity of 105,000 horse-power; the laying underground of 78 route miles of 20,000-volt transmission cables, the erection of 51 route miles of overhead 20,000-volt transmission lines, and the equipment of 346 miles of single track with 1500-volt direct-current conductors. In addition, sixteen sub-stations, having a total installed converting capacity of 116,000 horse-power, are being, or have been, erected, and 710 motors and trailers fitted with electrical equipment. The electrified system when completed will comprise a total of 125 route miles of double track and 20 miles of single track.

* * * * * *

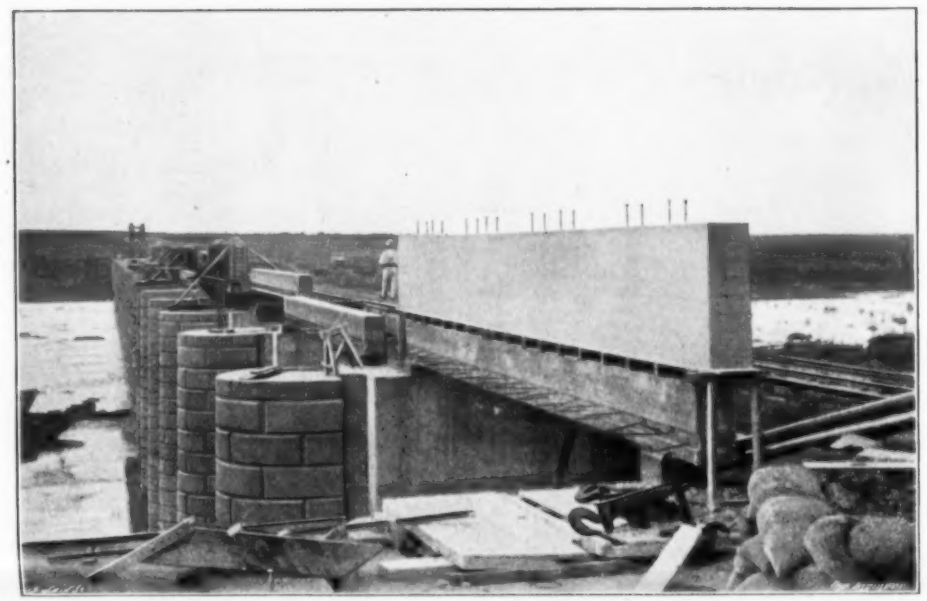
A computation has been made by the Government Statistician of New South Wales of the wealth of that Australian State as represented by (1) Government assets in the form of land, works, &c., and (2) private property. At the end of 1921 the total value of the two combined was £1,258,580,000, or £597.1 per head of population. Of this, Government assets represented £283,268,000. The estimate is a conservative one, since it is based on the capital cost of works many of which have a greatly enhanced value to-day as a result of the development and increased population in the localities concerned; and while allowance is made for depreciation, none is made for either appreciation or goodwill. The railways constitute the biggest item in the Government section, being set down at £97,459,000. Lands come next with £87,283,000. The balance is made up by water supply and sewerage works, harbour works, wheat elevators, forests, public buildings, &c. A comparison with the figures of 1891 shows remarkable growth and expansion. Apart from the

NEW BARRAGE ON THE VAAL RIVER

MR. W. INGHAM, M. INST. C.E., JOHANNESBURG, ENGINEER

VIEW OF EXCAVATIONS, SHOWING ROCK FOUNDATIONS AND COMMENCEMENT OF CONCRETING

CONCRETE APRON TO PREVENT EROSION OF FOUNDATIONS



REINFORCED CONCRETE BEAMS TO CARRY GOLIATH CRANE BEING CAST IN SITU

REINFORCED CONCRETE BEAMS AND OPERATING GEAR PLATFORM

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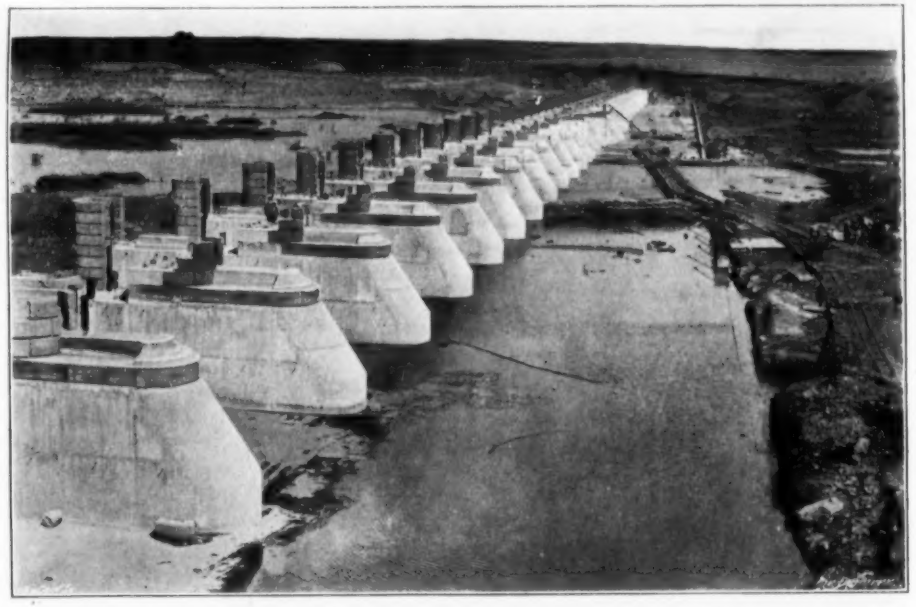
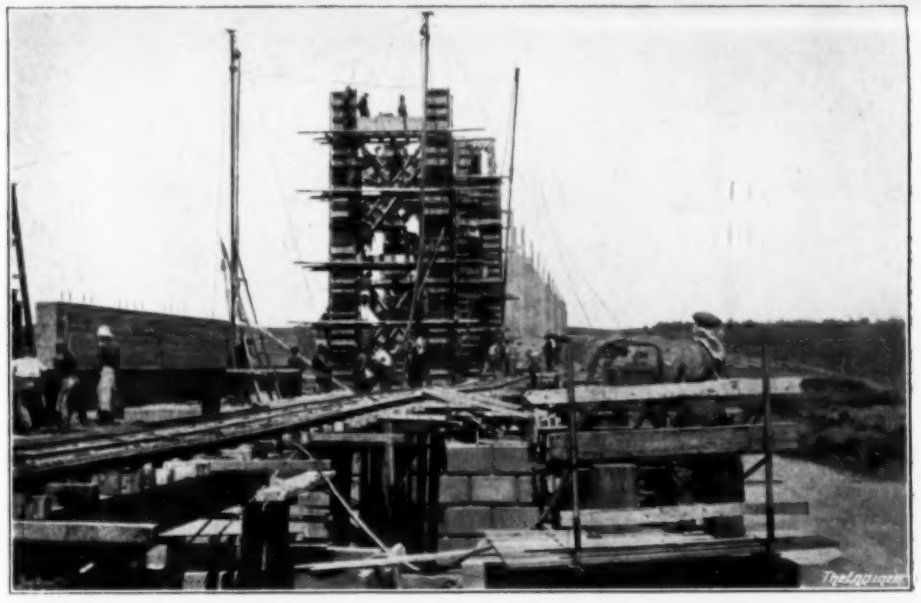
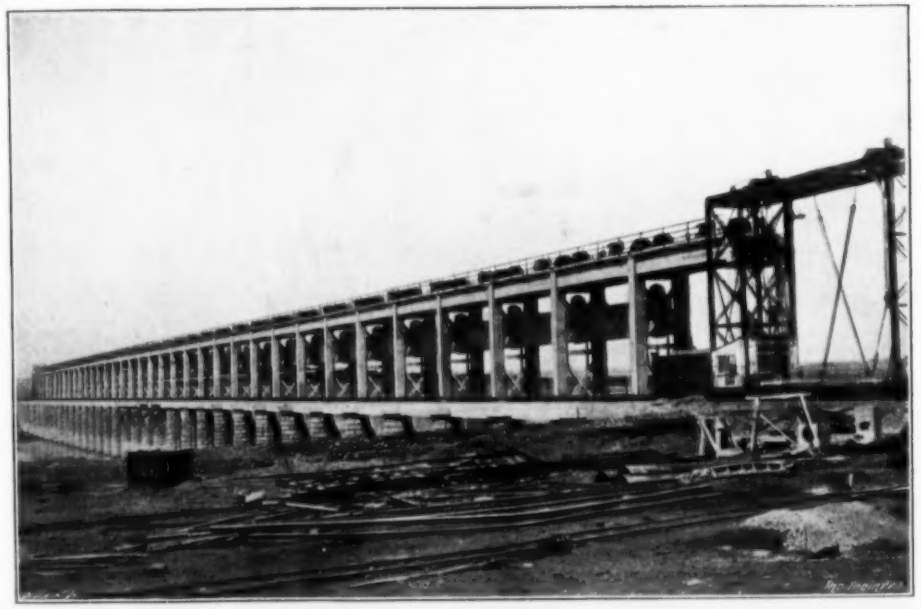


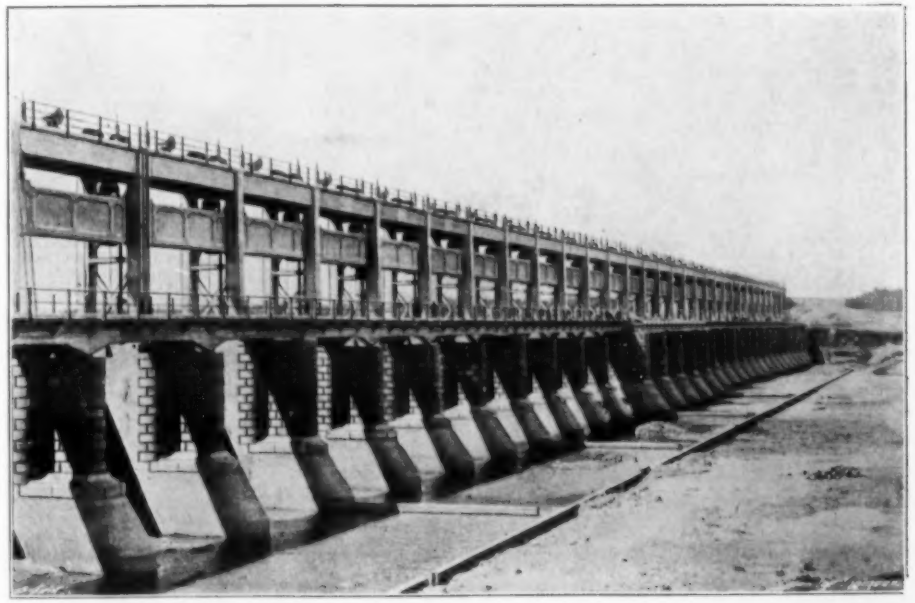
VIEW OF PIERS IN COURSE OF ERECTION, SHOWING DWARF WALL AND WATER CUSHION



SHUTTERING FOR CONCRETE SUPPORTS FOR SUPERSTRUCTURE



THE COMPLETED BARRAGE, LOOKING DOWN-STREAM



THE COMPLETED BARRAGE, LOOKING UP-STREAM

value of the public lands, the total value of State Government property grew from £65,271,000 to £195,980,000, or to just treble its original amount in that period. This expansion represented the investment in permanent works on State account of an average of £4,300,000 in capital each year, of which a very great part occurred in the ten years 1911–21, when the average annual investment was about £7,500,000. Apart from the very valuable assets of alienable lands there exist more than ample securities to cover the public indebtedness of the State even without consideration of the value of the goodwill of the trading concerns, which, when all contrary allowances are made, must still be very great.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Belgium Iron Prices Jump.

THE pervading tone on the Birmingham iron Exchange is an agreeable contrast to that of a month ago. In nearly all departments inquiries are more numerous, a very good sign being the greater readiness to negotiate forward business, a feature which had been entirely absent for several months. Demand fluctuates from week to week, but, on the whole, the outlook is more promising than it has been for some time past. The Staffordshire manufactured iron mills are, however, as yet unable to make more than half time, and there are still many cases of works shut down indefinitely until profit-making becomes once more possible. The marked bar mills are working at less than their full capacity. The Wages Board ascertainment is due in a few days, but no material change in selling prices or wages is anticipated. During the whole period, in fact, since April last, marked bars have been retained at £13 10s. per ton, and the profit margin is said to be narrow at that. Staffordshire unmarked bars for nut and bolt manufacture are still being quoted at £9 15s., though some mills are ready to accept £9 12s. 6d. and even £9 10s. to get a desirable order. With the recovery of the franc continental bar iron prices have "shot up" 15s. to 20s. per ton. Last week No. 3 Belgian bars were offered at as low as £6 f.o.b. Antwerp, or, roughly, £7 7s. 6d. delivered here; this week the quotation has jumped by stages to about £8 7s. 6d. per ton delivered. Buyers are consequently in a quandary, the effect of which is to hang up business. They hesitate to place orders at home at £9 15s., and are equally unwilling to place orders in Belgium with the prospect of prices being rushed up against them before the date of delivery. The consumer knows, however, that he can get his requirements supplied forthwith if he takes his business to the home producer, whereas he may have to wait an indefinite time if he sends it abroad, not to mention the greater waste incurred. Belgian prices are, however, still well below those of this district, and the Belgian bar mills have entered into pretty considerable commitments with the nut and bolt trade.

The Pig Iron Improvement.

The improvement noted last week in the pig iron industry continues, and again this week furnaces are finding readier outlets for their production. The foundries are taking rather larger supplies on the whole, and operating furnaces have now no difficulty in disposing of their output of foundry material. There is a disposition to buy pig iron somewhat more confidently, offers having been received to place contracts into the New Year. This class of business is not particularly encouraged by makers in view of the unprofitable prices at which pig iron is now being sold. The furnaces are badly handicapped by dear coke and high railway rates, and hopes are expressed that the railway companies, having completed their fusion schemes, will in the New Year make some concessions in their transport rates for coal and iron. Forge material is receiving very little more attention. Values are fairly steady, because the majority of the smelters prefer to let an order go rather than make further sacrifices. It is announced that a furnace for the manufacture of high-class foundry iron and cold blast material is likely to be restarted shortly in the Darlaston area.

Altered Steel Situation.

English steel prices are slighly firmer thanks to the recovery in Belgian franc values. The Belgians took full advantage of the low currency, and in certain departments substantial orders, particularly for half products, were placed abroad at the low prices which accompanied the decline of the franc. Our own producers are now feeling the effect, and unless there is a pronounced extension of consumptive demand they will continue to do so for the rest of the year. It would seem that some of our continental competitors are now beginning to have misgivings as to whether their operations at the time the franc was at its worst did not outrun the limits of discretion. Anyhow they have now promptly revised their quotations on the recovery of the market, and there has been a sharp rebound in prices. The continental fluctuations have entirely disorganised business in the buying department. Continental shippers wanted £6 10s. this week for billets delivered in the Black Country. This is 7s. 6d. more than they are reported to have been sold at a fortnight ago. Within a few days the quotations from Belgium have varied to the extent of 15s. per ton, and Birmingham merchants have been receiving daily telegrams from Antwerp modifying earlier quotations. The natural effect of this has been to arrest almost completely the buying of Belgian steel. It is also quite usual, where a quotation is offered, to specify from four to eight weeks as the period of delivery. This indicates the filled-up condition of the continental mills, and offers a real obstacle in the way of sales in this country, since English customers cannot afford to wait almost indefinitely for supplies. Moreover, by experience it has been found usually impossible to get delivery of steel when conditions have become less favourable to the Belgian steel maker. The general effect has been to turn the attention of consumers to the British steel works, whose maintenance of firm prices against the drastic competition of Belgium has already attracted attention, as indicating the stronger position of the manufacturer. Most consumers of billets are now sounding the home market with a view to business, with the result that prices are rather firmer on the basis of £7 and upwards. It is thought likely that certain steel works which became idle some weeks ago will restart earlier than was anticipated in order to handle this new business. There are a lot of inquiries in the market for finished steel, but the large steel works on the coast have now entered the competition in earnest, and for export business have frequently underquoted Midland re-rolling works. There is no important change in the leading categories of steel, though there are reports of impending advances in prices. Finished bars at £8 15s. are not remunerative, and makers would be glad if circumstances were such that they could get rid of this line. Some large orders have been placed for steel sheets in this district, a branch expected to become busy as the result of the improvement in motor building.

Black Country Mills Resume Operations.

Galvanised sheets maintain the improvement recently noted. Some of the mills in South Wales and elsewhere are stated to have sold their output over several months. The expansion of the trade particularly as regards overseas business has enabled additional mills to be recommissioned in this district after a long spell of idleness. For a long time past, three only of six mills owned by a firm at Tipton have been in operation; now, five are going. There are, however, still many Black Country iron mills unemployed. Prices are firm at £17 10s., a figure representing a considerable advance on the quotation of a month ago.

The Wire Price Reduction.

The drop in mattress wire, amounting to £2 10s. per ton, reported in this column a week ago has not stimulated demand. The most that can be said of it is that it will put makers in a better position to combat American, Canadian, and German competition when trade does revive. The screw and rivet wire branches are active.

Rolling Stock Orders for Birmingham.

It is understood in Birmingham iron and steel circles that the lion's share of the railway wagon contracts for India falls to one of the big firms of Birmingham and the Black Country. Only a few details now await settlement, the main decision, it is stated, having been taken. This is good news for the trading and industrial interests connected with the wagon works. Business has been very difficult to get since the war, and the orders reported two or three months ago only provided employment for less than half of the plant and *personnel*, taking the district shops all through. The Indian contracts represent 3000 wagons in all. Exactly what proportion is placed locally is not disclosed, but it is, at all events, more than half.

Less Unemployment in the Midlands.

It is pleasing to be able to record, as indicating the upward trend of business generally in this area, that unemployment in the West Midland area is on the decrease. With the exception of one week ended November 6th, there has been a reduction in the number of unemployed every week from October 23rd, and since November 6th the figures have decreased, so that the most recent returns show the lowest number of unemployed for a long time past. The figures show the number of unemployed to be 170,173, a decrease on the previous week of 3169. Of this decrease Greater Birmingham is responsible for no less than 2784. The numbers in the various important towns in this area now stand at:—Birmingham area, 57,540; Walsall, 7066; West Bromwich, 4632; Wolverhampton, 10,548; Coventry, 7880; Cradley Heath, 7858; Darlaston, 2097; Dudley, 5452; Smethwick, 7848.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

General Conditions.

IT may perhaps be admitted that the metal and iron markets in Manchester have arrived at, or are near to, the stage of convalescence; but it is certain that, after so prolonged an illness, this stage will be weary and full of disappointments. That there is any prospect of a quick recovery to full strength and vigour is highly improbable, unless the trade is fortunate enough to have many such fillips as was given to the pig iron trade recently, when the Americans were forced to come here for supplementary supplies. That incident was, one fears, rather in the nature of the stimulant, such as invariably leaves a re-action behind it. If it be true that the trade is now convalescent, there is much to be thankful for, but we shall want to see a much larger proportion of our productive capacity at work before we can indulge in any anticipations of returning prosperity. Much is now hoped for as a result of a return to stable government, but commercial confidence is a plant of very slow growth, and one does not look for any very definite improvement from week to week.

Metals.

The market for copper has been dull again, and the recent advance has been lost. The fluctuations in standard copper for the last six months have been very trifling, and one may be fairly sure that this steadiness is an indication that the market is at the bottom, but there is no indication that any upward movement can yet be expected. It was thought by some that when operators in tin had obtained all that they could get by manipulating that market they would turn their attention to copper, but so far one cannot find any sign that they are thinking of doing so. Probably they will realise that the time has not come for any such attempt, for the assistance of the consuming trades is not likely to be obtained until business generally is much better. The prices current for electrolytic copper have been somewhat affected by the strength of the American Exchange. At one time the rate in dollars for the £ sterling went well over 4.50, but it is yet impossible to say whether this is an indication of an early return to full values for our currency. The price of electrolytic ingot has also been affected by the current belief that the production of copper in America will soon be greater than the consumption. The position as regards manufactured copper does not show much change here, but there is no doubt that the prices are kept at too high a level. It appears that Germany is taking a good deal of the Eastern business in copper and brass rods and sheets, which used to be the perquisite of the British copper manufacturer; and one cannot be surprised at this result, for the German maker will certainly be contented with much less profit than is supposed to be necessary for the British maker. The German exports of copper rods and sheets up to the end of September were 4798 tons, of which more than 2000 tons were shipped to British India. The demand for tin from the South Wales works is said to be better than it was; this may probably be true, but it has not enabled the market to make much progress. The forces which drove tin up to £184 per ton had nothing to do with demand; but if the Welsh tin-plate trade continues to increase its output, it will help the market to withstand the reaction which followed the recent bull speculation. The view of market experts who have no selfish interests to serve, seems to be that rather lower prices are likely to prevail for a little time. The demand for lead keeps steady, although the prices are comparatively high. Since the rise in spelter, however, lead does not appear to be so dear as it was. When lead prices and spelter prices were nearly on a level, it was natural to feel that lead was extravagantly dear. Spelter has been an easier market, and at one time the drop amounted to a fall of £4 from the top prices. It is thought that the galvanisers have not yet begun to accumulate stocks of spelter, and that they are, in most cases, rather bare of supplies.

Pig Iron.

The position in the Manchester foundry iron market does not seem to alter much. The slight increase in price now asked by most of the Derbyshire makers, based on 83s. 6d. per ton at the furnaces for No. 3 does not check buying, although perhaps it is doubtful whether quite so much forward buying is being done. The iron at 91s. delivered in Manchester is still fairly cheap, as the Cleveland ironfounders are still asked to pay 92s. 6d. at the furnaces in their neighbourhood. The condition of the foundry trade, so far as supplies of iron are concerned, are still very different from what it was when Cleveland No. 3 was the cheapest iron in the country. It is said that the founders of this district are now better off for work, but the improvement in this respect cannot have gone very far at present. The demand here for common iron is fairly good, but that for Scotch iron is small; and, of course, it is natural that the ironfounder should avoid the use of Scotch iron whenever it is possible for him to do so. Scotch pig is a little easier here, but 112s. 6d. per ton is about the lowest at which it can be bought, delivered in the district, and this is still more than £1 above the cost of common iron.

Steel.

There are reports from other centres of the steel trade which suggest that some improvement is taking place; and as several hematite furnaces and one basic furnace are being put into blast, we may perhaps assume that there is something behind these reports; but in Manchester it is difficult to find any sign of improvement, and the trade seems much as it has been for months. Mostly small orders are fairly plentiful, but the aggregate tonnage cannot be very large; and the prices are as they were, which means, of course, that the steel works are not making adequate profit.

Scrap.

The increasing demand for ordinary heavy steel melting scrap is perhaps another indication that the steel trade is not so bad as it was. Apparently the value of this class of scrap has now come up to 60s. per ton in Lancashire, or a total rise, from the lowest point, of 15s. per ton. Heavy wrought scrap remains neglected at about 60s. delivered at the ironworks. There has been a slightly better demand for good cast scrap, and possibly 80s. per ton might now be obtained for broken machinery metal, and 85s. to 87s. 6d. per ton for best "textile" scrap. The prices are still low compared with pig iron, but the worst of the depression may possibly be passing away. Cast scrap is certainly a cheap material for the ironfounder, and he should use it more freely.

Plate Moulding.

A paper on the subject of "Plate Moulding" was read before the Manchester Association of Engineers on Friday last by Mr. W. Norman Cook, B.Sc., the author being the latter's father, Mr. W. H. Cook, M.I. Mech. E. Mr. Daniel Adamson presided, and there was a large attendance of members. Mr. Cook said that plate moulding could be adopted for the majority of castings. He had for years been using plates as large as 8ft. square, but he did not advocate large boxes, 16in. by 12in. being probably the best size for both 3in. and 4in. top and bottom parts. He recommended that as far as possible patterns should be made so that they will part across a dividing line which in a symmetrical pattern is across the centre. Patterns made in this manner, the author said, cost no more than solid ones, and even if they had to be used as loose patterns the advantages were great. The moulder, with either large and small patterns, could put one half of the pattern on a flat board

and ram up the bottom box; then turn it over and place the other half of the pattern in position and ram up the top box, thus saving the trouble and time spent in making "odd sides" and reducing the risk of making dirty castings through loose sand. With regard to methods of working the plates, the author prefers the hand ram self-draw machine, from which he said he had obtained at least 10 per cent. greater output than from working on the floor or on a bench. He said that a further advantage of the machine was that the castings were more accurate to pattern on account of the small amount of clearance required between the pins and the holes, namely, $^{4}/_{1000}$in. compared with $^{10}/_{1000}$in. when hand drawn. Another advantage was that men could be trained more quickly. The paper described methods of preparing the patterns, drawing patterns through a matrix, and the use of "match" plates. By the use of the last-named only half of the usual number of patterns is required. The paper was illustrated by actual patterns, and led to a lively discussion on foundry methods and management.

Institution of Structural Engineers.

A meeting of local members of the Institution of Structural Engineers and others was held at the Victoria University, Manchester, on the 25th ult., when it was decided to form a Lancashire and Cheshire branch of the new society which, if the expected legal authorisation is given, is to be known as the Institution of Structural Engineers, and which will replace the existing Concrete Institute, the members of which feel that a more comprehensive title is necessary. The chair was taken by Mr. E. F. Etchells (president) who advocated the foundation of courses of study in structural engineering in Lancashire and Cheshire. Mr. A. S. Spencer (of Heenan and Froude, Limited), Manchester, presided. He said that if the Institution of Structural Engineers did as much for the profession as a whole as the Concrete Institute had done in the matter of reinforced concrete work, it would achieve a great object. The secretary of the institution is Captain M. G. Kiddy, Newton Heath Ironworks, Manchester.

The Engineers' Club.

The extensions of the premises of the Engineers' Club, Manchester, which have been in hand for some months, are now almost completed, and the committee hopes to place the new rooms at the disposal of the members in a week or two. These extensions are the first of a series which, when complete, will enable the membership to be greatly increased. The portion to be opened immediately includes a large new dining and grill room, small private dining room, library, and ladies' rooms, while the service arrangements have been improved. Next year it is intended to proceed with a further extension of the smoking room floor.

The Engineering Trades.

The modest revival in the local engineering trades which I reported in this column at the end of October is still being maintained, and the number of persons receiving unemployment pay has been further reduced, but the improvement is not yet general enough to encourage much hope for the future. While some shops are busy others are extremely slack. Among the latter are the machine tool makers. They, however, have reason to hope for some benefit in no very distant date, by the decision recently made by American machine tool builders to increase their prices all round. Several substantial orders for locomotives have recently been placed in Lancashire, chiefly with the Vulcan Foundry Company, at Newton le Willows. Nasmyth, Wilson and Co. have also booked some engine orders for India. The heavier side of the electrical trade is still well supplied with work, and a similar remark applies to the textile machine builders, but stationary engine builders—both steam and internal combustion—are with one exception much in need of work.

Barrow-in-Furness, Thursday.

Hematite.

There is plenty of optimism in the hematite pig iron trade, and hopes are expressed that the demands will necessitate the putting in of more furnaces at an early date. It is not in any particular direction that the increased demand comes from; it is general. The Continent continues to take a considerable quantity, and both the Midlands and Scotland are now taking increased deliveries and, what is more, are placing orders of some weight for forward deliveries. It is the evidence of these future deliveries that lead one to anticipate better trade still in the early future. In special classes of pig iron there is a growing trade, and manganese and spiegel is experiencing better business. The fact that the steel works are doing little reduces the consumption of iron on local account, and no doubt determines the number of furnaces to be put into blast. There are now sixteen blowing.

Iron Ore.

The iron ore trade is improving, and more is being sent out of the district, especially from Hodbarrow. The mines are not in full work yet by any means, but there is a better trade, and the prospects are better. The stocks of foreign ore are being reduced at the docks, and when they are down more will be imported.

Steel.

The steel trade is dull at the moment, but hopes are expressed that now that the various railway combines are established, that there will be an inquiry for rails, as very little in the way of renewals have been indulged in since 1914. The foundries are partially employed, and the hoop mills at Barrow are engaged in some departments.

SHEFFIELD.

(From our own Correspondent.)

Improvement in the Steel Trade.

At last it seems quite safe to say that the Sheffield heavy trades have turned the corner of depression, that more work is coming in, and that a good deal more is in prospect. Three optimistic speeches by authorities on the subject have been made during the past week, and inquiries in various quarters yield further evidence of the upward movement. Of course, we have a long way to go yet before trade reaches anything like normal proportions. There are still over 37,000 names on the unemployment registers. But this figure shows a decline of 1142 as compared with the previous week, and, as a matter of fact, there is less unemployment in the city now than has been the case for the past two years. All the same, the improvement is not expected to be rapid. A severe winter is looked forward to, and Sheffield will be glad of any Government or other public assistance that can be given. The proposal that the railway managers shall consider what constructional schemes they can expedite was received with great interest in the city, the leaders of which are doing all they can to further its trade interests. In the House of Commons on Monday, one of the local members put a question to the First Lord of the Admiralty with a view to hastening the placing of contracts for the two new battleships; and on the following day the Lord Mayor and other municipal representatives met a body of Sheffield members at Westminster, in order to confer with them on the urgency of the situation and provide them with material to place before the House.

The Outlook.

One of the optimistic speeches to which I have referred was made at the annual meeting of Brown Bayley's Steel Works, Limited, by Mr. R. Mainprice, one of the directors. The firm was very badly hit by the depression during the period ending June last, and made a heavy loss, but Mr. Mainprice stated that August, September, and October showed infinitely better results than any they had had since October, 1920, the turnover being twice the average for the previous financial year, while November, up to date, showed a further advance. Indications were, he said, that, unless there was some serious upheaval, their trade would go upwards and not downwards. The average number of men employed in 1921 was 1145 per week, and in 1922 it was 1150, but for the first week in October last the figure was 1450, and the men were also working a greater number of days per week. The second speech was made by Mr. G. H. Cowen, managing director of George Turton, Platts, and Co., Limited, who are large makers of steel, especially for railway purposes. He said that at the present time large orders for locomotives, wagons, carriages, and other railway material were being placed in this country, and he knew of some very large ones which were coming forward. He predicted that by the spring the bulk of the unemployment would have passed away. The third speaker was Mr. Arthur Balfour, who expressed the conviction that within the next nine months the country would be in a very different position from its present one, and would be doing a very substantial trade.

Conditions in the Workshops.

The furnaces producing basic steel continue very well employed, and a large tonnage of that material is being made. There is a falling off in South Wales competition in the Midlands, and this is increasing the openings for Sheffield products. The demand for acid steel is improving, but this department could still do with a lot more work. There is a steady increase in the volume of orders for railway steel. The crucible steel trade shows some improvement, and some additional furnaces have been brought into operation during the week, but there is no regular flow of orders for this branch. High-speed steel is still in very poor request. Owing to the slackness in shipbuilding, the foundries turning out marine castings are poorly employed, but as contracts for new vessels have been placed at several of the shipyards, business from this quarter should increase shortly. Steel plates and tools used in ship repairs are in better demand. There is a good deal of complaint about steel work being taken at unremunerative rates, but the period of severe price-cutting seems to be passing away. In several directions there is a stiffening of prices of steel material, and it is thought that this tendency, indicating that bottom quotations have been reached, will stimulate the placing of orders that have been held back in the hope of further reductions.

Progress of Stainless Steel.

New uses are being continually found for stainless steel, which is one of Sheffield's great assets. Brown Bayley's report that the demand for this material is improving, increasing, and widening every week, the movement relating not only to the home trade, but also to export. Brown Bayley's are at present making some large rolls of stainless steel 9in. to 11in. in diameter and 8ft. to 12ft. long for the paper trade, and they are hoping that if this venture is satisfactory the great textile trade of Lancashire will come along and demand a large quantity of smaller rolls. It is also reported that a well-known firm of stainless steel manufacturers is making a diving suit of the material. Hitherto, these equipments have been made of copper. The new development will provide an opportunity for fully testing the behaviour of stainless steel when exposed to sea water, and will be watched with much interest.

Electric Steel Development.

Another development of much interest is a new steel-making process, which promises to revolutionise electric melting, that has been put into operation at the works of Edgar Allen and Co., Limited, Tinsley. The Stobie Steel Company has installed for the firm one 10-ton and one 3½-ton electric steel melting furnace, which are being worked together as a single unit under the Stobie process. It is claimed that the load factor is greatly increased by the continuous working; that the power factor is much improved by the maintenance of, mainly, molten baths; and that fluctuations of current are less marked and of shorter duration. There are also metallurgical advantages. One is the frequent supplies of small quantities of steel, of varying compositions if required, at the low cost of operating plant of large output. Much less space is occupied by the plant than by an installation of several furnaces working independently, a reduced crane service is required, there is a great reduction in the repairs to furnace linings for a given output of steel, and a freer choice in scrap for melting.

The Smoke Problem.

The question of smoke prevention, now very much before the country, is of special interest to Sheffield, where it is greatly feared that any interference with the present liberty to emit black smoke from certain classes of furnaces would have a disastrous effect on some of the most important trades. A recent lecture by Professor Desch, the well-known chief of the metallurgical side of the University, is therefore of importance. He pointed out that gas furnaces had a tendency to oxidise the steel and to take some of the carbon out of it. While this did not matter much in girders, ship plates, and that sort of thing, it was essential in high-class steels that oxidation should be avoided and the whole of the carbon retained. Some steels necessitated close contact with carbon in the furnace, and this was obtained by burning a black smoke in the furnace, which gave off a great deal of carbon owing to the restricted volume of air. He believed that these high-class steels could be produced without the emission of smoke, but not with the existing plant. Reconstruction could be carried out whereby smoke after it had left the furnace could be burnt and passed off as a clear, transparent product. In building new furnaces they could arrange for a secondary furnace to burn the smoke, but at present, owing to the industrial depression, the industry could not afford great reconstruction schemes.

The Lighter Trades.

The makers of hand tools and hack saws are enjoying better trade, but engineers' small tools are not in very good demand, although the Colonies are buying on a more liberal scale. The cutlery and plate branches are still busy, but are noticing a falling off in trade, and it does not appear likely that the present great activity will be maintained until the end of the year.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Trade Position.

Although the general trade position in the North of England shows little change on the week, manufacturers take a more hopeful view of the outlook, and have solid faith in an expansion of trade. The Premier's negotiations with the railway companies are being eagerly watched, for if his schemes for railway reconstruction take effect they will undoubtedly give a big fillip to the heavy steel trade in the North of England. It is understood that the schemes under consideration on the North-East Coast include, apart from the proposed electrification of the main line between York and Newcastle and associated sections, the erection of a bridge over the Tyne from North to South Shields, and the extension of the docks at Blyth to improve the accommodation for vessels engaged in the coal export trade.

Cleveland Iron Trade.

While the real strength of the Cleveland pig iron market at the moment is based upon home requirements, there are signs of better trade with the Continent, where prices have sharply advanced. The American demand for all classes of iron has fallen off for the time being, but there are substantial shipments to be made over the first quarter of next year, and the shortage of material across the Atlantic is such that further business is expected. At the moment, however, urgent needs are satisfied, and there is no necessity and no inducement to buy very far ahead with all the attendant uncertainty and risk. So far as the home trade is concerned, more and more pig iron is now needed for steel making, and the starting of more furnaces to meet the increasing requirements is foreshadowed early in the New Year. The price of No. 3 G.M.B. Cleveland pig iron is firmly maintained at 92s. 6d. per ton, but No. 1 is easier at 96s. 6d., and No. 4 foundry is down to 87s. 6d. No. 4 forge is not in great demand, and though quoted at 85s., might be bought as low as 82s. 6d., and mottled and white at 81s. per ton f.o.t. or f.o.b.

Hematite Pig Iron.

The position in the East Coast hematite pig iron trade has shown considerable improvement. The demand both on home and foreign account has broadened out, and two more furnaces have been re-started. Mixed numbers are steady at 93s. per ton, and No. 1 at 93s. 6d., some makers asking 6d. more.

Iron-making Materials.

The foreign ore trade is extremely quiet. Buyers cannot be induced to trade, and quotations are purely nominal. With the Bilbao freight at 8s., best Rubio ore might be obtained at about 22s. per ton c.i.f. Tees. Coke is a shade easier, there being sellers of good furnace qualities down to 29s. 6d. per ton delivered at the works.

Manufactured Iron and Steel.

There is a decidedly improved tone in the manufactured iron and steel trade, and makers are much more favourably situated, the demand for railway, shipbuilding, and constructional material being on the up grade. Offers of cheap foreign steel having been cut off, there is also a better demand for British billets, and prices

have been further advanced. Soft billets are now sold at £8, medium £8 10s., and hard £8 15s. per ton. Other quotations are firm and unchanged.

The Coal Trade.

The entire range of the Northern coal trade has improved, and there appears to be a more cheerful atmosphere prevailing in most directions. During the past few days there has been quite a respectable amount of forward contracting by merchants, which has served to assure and strengthen the market for a time ahead. There has been a distinct hardening of prices. One of the contributing factors—perhaps the most important one—is the approach of the holidays. There is, of course, no advance in the quotations in any case. But what is happening is that the second-hand men, who at present rule the market, are rather less afraid than they were a week or two ago, and are therefore not so inclined to discount prices, with the result that there is a slight improvement in the value of purchases indirect. Another factor is the prospect of a quicker dispatch at the principal loading places, though as yet there is no definite announcement of the re-commencement of the three shifts for trimmers and teemers. It is confidently expected, however, that this will be the result of the recent conference. Actual buying on overseas account is somewhat quiet at the moment, but from advices to hand there is every likelihood of an expanding inquiry. The shipments to Germany are curtailed at present, but orders are coming forward once more, while feelers for next year are being made. The French and Italian shipments are not what they should be, but there have recently been placed considerable commitments on account of next year, which should soon be reflected in increased shipments. There are a number of Belgian shipments at present going forward, and the outlook is better. Scandinavian business is also improving Best Northumberland steams and also seconds continue firm in price for any early shipment or any date of shipment up to April next. The position for steam smalls is rather better than it was, though they are still plentifully offered, and are easy. Special gas coal, as well as prime brands, continue strong, while coking and bunkers are scarce and stronger. Coke is a very steady market for both gas and foundry makes of nearly every brand.

SCOTLAND.

(From our own Correspondent.)

Brighter Prospect.

If the improved conditions in shipping at Glasgow Harbour can be taken as an indication of the trend of things the situation must seem to show increased activities with the promise of still better things in store. It is said that shipping movements of late have been more numerous than at any period since the industrial depression commenced, and that vessels are now securing fuller cargoes than have been obtainable. An improvement is noticeable in the ore traffic, while in export directions heavier shipments of general cargoes have been dispatched to India, Australia, and the Far East, and a better demand has been experienced for cargo space between this country and North and South America. It is noteworthy that to-day only two vessels are laid up in Glasgow, whereas about three months ago there were at least eight or nine.

Smaller Demand for Pig Iron.

For some months past the Scottish pig iron makers have had no difficulty in disposing of outputs of foundry qualities owing to American demands. This business has now practically ceased, and any cargoes still going are against old contracts. The home demand for foundry shows little sign of expansion, while the foreign demand is quiet. The advance in the price of fuel has raised the cost of production. Consequently, with the market weakening, it is likely that some furnaces may be put out of blast.

Steel and Iron.

Steelmakers have little increase in business to report. New orders are indicated, but few works show any signs of a larger turnover so far. Specifications for plates and sectional material are still very scarce, and no great improvement is looked for this year at least. Sheet makers are still fairly busy, chiefly with orders for the Eastern markets. A slighty better demand for bar iron is reported, but not of sufficient importance to have much effect on the works in general. Local consumers, however, have been booking orders which eventually must provide work for the ironworks. The wrought iron departments are busier, and further orders are in prospect. Boiler plates have been reduced 10s. per ton, and the controlled price is now £12 per ton delivered Glasgow stations.

Coal.

Considerable activity has been maintained in the export departments of the Scotch coal trade. In all districts the collieries are well booked up until the end of the year for best qualities of round coal, while second-class stuffs have secured orders of considerable bulk. Prompt orders for shipment are difficult to place, and in most cases are only secured through second hands. Treble nuts are busy with export business, and have also good orders for home delivery. Double nuts are improving, but smaller sorts are not doing much at present. Considerable congestion still exists at the Fifeshire and Lothian ports, and at the former the loading turn is one of fully a week. Aggregate shipments amounted to 296,996 tons against 321,648 tons in the preceding week, and 280,122 tons in the same week in 1913. In the home market house coal is busy, and gas, electricity and railway requirements are heavier, but general industrial business is still far below normal. Prices on the whole are firmly maintained.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

The returns regarding the quantity of coal exported from this district last week were far from satisfactory, inasmuch as there was a reduction of close upon 60,000 tons as compared with the previous week, and, in fact, the total was the lowest for any week since October 26th. At the same time, there was a perceptible improvement in the tone of the market during the second half of last week. Stems filled up pretty rapidly, and the bulk of the collieries are, so far as their books are concerned, well placed practically up to the end of the year. Whereas they were prepared previously to shade prices for prompt shipment, salesmen are now holding out more firmly. There is not, however, a good deal of inquiry coming along, and, comparatively speaking, the amount of business being done for supplies for shipment over the first half of next year or the whole of the year is negligible when set against the normal quantity arranged by this time in pre-war days. One colliery producing second Admiralty large is reported to have sold three-quarters of a million tons at the price of 25s. for delivery over the next twelve months, and there are negotiations going on between coal exporters and buyers abroad for supplies over a period, but buyers do not appear at all keen to purchase any substantial quantity ahead unless they can get in at prices which at the moment are considered to be too low for firms on this side to accept with reasonable risk. The Dutch Railways are reported to have bought about 20,000 tons of Monmouthshire coals for delivery by the end of December, and it is believed that the Belgian State Railways are disposed to consider contracting, but so far particulars as to their requirements are not known.

Dock Delays.

The question of dock delays and the steps to be taken to remedy the position continues to be the burning topic in coal export and shipping circles. Matters are moving as fast as can reasonably be expected, though, of course, traders who consider that they have cause for complaint may be of the opinion that the progress made towards remedying grievances is somewhat slow. The necessity for a revision of working conditions at the docks is becoming increasingly evident. Information regarding specific cases of delay is being collected, and there is no doubt that by the time the men's representatives are induced to meet to discuss the demands for the introduction of a third shift, the employing interests should be able to submit a good case. Only last week-end there was a case of a 10,000-ton steamer being detained from the Saturday to the Monday for the sake of two hours' work. In pre-war days it would have been possible for extra time to have been worked on the Saturday afternoon, but under present conditions this is not possible. One of the great points which will be made when the whole question is discussed is that the extension of working hours and the re-establishment of a third shift will help to diminish unemployment. It will mean that more men can be employed at the docks, and when in times of pressure coals are cleared more expeditiously, it will have the effect of providing empty wagons more regularly and do away with one cause for irregularity of work at the collieries. According to the chief docks manager of the Great Western Railway Company, a special staff is engaged in recording and analysing all delays. All cases are investigated and exhaustive reports are supplied to the chief docks manager. No less than forty-four causes of delays are tabulated in a return with extra columns for any additional cause out of the ordinary. Mr. Vickery also points to what the Great Western Company has done, and is doing, to effect repairs and install new plant, and after appealing for the co-operation of the men, he states that the obvious remedy for avoiding keeping ships waiting is to put on a third shift, while the pooling of wagons would help the position in many ways. It may be added that the General Committee of Traders has appointed a sub-committee to meet officers of the Great Western Company to discuss matters of mutual interest, and a meeting of a private character was held on Tuesday of this week.

Current Business.

Although business cannot exactly be described as active, there is no doubt that the general tone of the steam coal market is very steady and better than was the case last week. The docks are still well supplied with tonnage, and a fair number of steamers are waiting their turn to get into berth. The commitments of the collieries are sufficient to keep them busy for some weeks to come, and consequently those producing the better classes have very little free coal to offer. There is every indication that the loading pressure will be well maintained up to the Christmas holidays. Best Admiralty large coals are firmly quoted at 28s., and in some cases as high as 28s. 6d., while second qualities are very steady at 27s. Superior Monmouthshire large are quoted at 25s. 6d. to 26s., and the minimum price of best steam smalls is 16s. Highly bituminous coals are heavily booked, and the demand for dry descriptions is well upheld. Patent fuel meets with a rather moderate inquiry, but manufacturers of this commodity are not in a position appreciably to reduce their prices owing to the high cost of pitch. Anthracite coals are not so firm. This applies more especially to large qualities, though sized coals are less plentiful and keep up well.

Swansea Metal Exchange.

The tin-plate market is rather quieter, the reason being the fall in the price of block tin, but the export business continues on a steady scale.

Shipping Repairs.

The ship-repairing industry has been very quiet for some time, but the contract, amounting to several thousand pounds for the repair of the ss. Portreath, which was considerably damaged by collision in the Barry Roads with an American steamer, has been secured by Mountstuart Dry Docks and Shearmans, Limited, of Cardiff, and the work will be carried out at Newport. Another repairing job on the ss. Largo Law, which was considerably damaged by grounding, will be carried out at Cardiff by Messrs. Elliot and Jeffrey.

INSTITUTION OF ELECTRICAL ENGINEERS.

The following is a list of the successful candidates in the A.M.I.E.E. examination, October, 1922 (Officers of the Corps of Royal Engineers):—2nd Lieut. T. E. Abraham, Lieut. E. Bader, 2nd Lieut. G. L. Baker, 2nd Lieut. P. K. Benner, 2nd Lieut. W. D. H. Beyts, 2nd Lieut. H. J. Bourne, 2nd Lieut. P. B. H. Carden, 2nd Lieut. H. P. Cavendish, Lieut. J. L. H. Chase, Lieut. W. J. C. Chevis, Lieut. A. R. Churchill, 2nd Lieut. G. C. Clark, 2nd Lieut. G. G. S. Clarke, 2nd Lieut. D. W. A. Cleeve, 2nd Lieut. W. S. Cole, 2nd Lieut. E. Colvin, 2nd Lieut. E. F. B. Cook, 2nd Lieut. J. V. Davidson-Houston, 2nd Lieut. J. F. Doelberg, 2nd Lieut. A. G. Drake-Brockman, 2nd Lieut. D. G. Fraser, 2nd Lieut. R. C. Freeman, Lieut. E. H. T. Gayer, 2nd Lieut. L. F. Hancock, 2nd Lieut. R. H. Havers, 2nd Lieut. W. R. Healing, 2nd Lieut. F. M. Hext, 2nd Lieut. R. E. Holloway, 2nd Lieut. S. G. Hudson, 2nd Lieut. G. W. D. Jennings, 2nd Lieut. H. S. Kay, 2nd Lieut. E. R. Laurence, 2nd Lieut. R. A. Laurence, 2nd Lieut. J. F. M. Leese, 2nd Lieut. A. R. Logan, 2nd Lieut. J. H. B. Lowe, 2nd Lieut. A. R. S. Lucas, 2nd Lieut. J. E. C. McCandlish, 2nd Lieut. D. G. G. Macdonald, 2nd Lieut. E. McDonald, 2nd Lieut. K. Mackay, 2nd Lieut. D. McMullen, 2nd Lieut. K. F. MacTier, 2nd Lieut. C. J. M. Martin, 2nd Lieut. R. K. Millar, 2nd Lieut. H. L. Moscardi, 2nd Lieut. G. H. B. Moss, 2nd Lieut. T. D. Oborne, 2nd Lieut. H. M. O'Donnell, 2nd Lieut. G. A. Palmer, 2nd Lieut. G. E. H. Philbrick, 2nd Lieut. M. R. R. Prentice, Capt. A. J. Ransford, 2nd Lieut. D. M. Rycroft, 2nd Lieut. J. M. Sangert, 2nd Lieut. H. R. Scullard, 2nd Lieut. W. A. R. Smith, 2nd Lieut. C. D. Steel, 2nd Lieut. E. C. S. Stowell, 2nd Lieut. L. H. Stowell, 2nd Lieut. N. A. M. Swettenham, 2nd Lieut. G. N. Tuck, 2nd Lieut. W. L. D. Veitch, 2nd Lieut. A. A. C. Walker, 2nd Lieut. E. W. L. Whitehorn, 2nd Lieut. P. L. Wilkinson, 2nd Lieut. H. W. Wright.

The following is a list of the successful candidates in the A.M.I.E.E. examination, October, 1922:—Passed whole examination: R. E. Atkins, C. Austin, C. C. Bleach, C. Cameron-Kirby, W. J. F. Debley, E. J. Gorton, W. F. Crosswell, E. D. A. Herbert, F. W. Hine, I. L. Jones, D. H. C. Lye, T. McClean, H. E. Morrish, E. R. Pennell, C. H. Smith, E. H. Taylor, F. P. G. Telfer, H. Wainbom, C. Wilkins, T. Williams. Passed Part II. only: J. N. Badhni-Valla, E. W. Braendle, A. J. Randall, F. W. J. West, R. Wright. Passed Part I. only: O. K. Bee, N. C. Weston. Results relating to candidates who sat for the examination abroad will be published later.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

We are informed that the business of Shand, Mason and Co., the fire-engine builders, of Southwark, has been sold to Merryweathers, of Greenwich.

We learn that Mr. Henry L. Curnock, for some years the advertising and publicity manager to Geo. Cradock and Co., Limited, of Wakefield, has resigned his engagement with them.

Monsieur R. E. Mathot asks us to state that he has moved his office from 81, Rue du Marteau, to 29, Rue René Dubreucq (Place de Londres), Brussels. His new telephone number is 216.45.

Associated British Machine Tool Makers, Limited, inform us that they have removed their office from Bank Buildings, 63, Blonk-street, Sheffield, to 4, Summerfield, Broomhill, Sheffield. New telephone number, West 217.

The Consolidated Pneumatic Tool Company, Limited, of Egyptian House, 170, Piccadilly, London, W. 1, asks us to state that, owing to the expiry of its lease, it has removed its pneumatic and electric repair shops and showrooms from 73/75 and 79/80, Petty France-street, Westminster, to 23a, Bramber-road, West Kensington, W. 14, where all goods and machines returned for repair should be sent. There will be no change in its head office address.

The Consolidated Pneumatic Tool Company, Limited, of Egyptian House, 170, Piccadilly, W. 1, informs us that it has appointed Captain Colpoys C. Walcott, R.N. (Ret.), as its district manager for the Bombay territory. Captain Walcott is on his way out to take up his duties in the place of Mr. Rowland Jones, late district manager, who has unfortunately been ordered home owing to ill-health, and has had to relinquish his post. The Bombay address of the company is Amarchand Buildings, Ballard-road, Fort, Bombay.

The Faraday Society.—At the annual general meeting, held on November 20th, the following officers and council were elected to serve for the year 1922–1923:—President: Sir Robert Robertson, K.B.E., F.R.S.; past-presidents: Sir R. T. Glazebrook, K.C.B., F.R.S., Sir R. A. Hadfield, Bart., F.R.S., and Professor A. W. Porter, F.R.S.; vice-presidents: Professor C. H. Desch, Professor F. G. Donnan, F.R.S., Dr. J. A. Harker, F.R.S., Professor T. M. Lowry, F.R.S., W. Murray Morrison, Professor J. R. Partington, and Dr. G. Senter; treasurer: Robert L. Mond; council: W. R. Bousfield, K.C., F.R.S.: Cosmo Johns, Dr. R. Lessing, Professor W. C. McC. Lewis, Professor J. W. McBain, Dr. H. Moore, C. C. Paterson, Dr. J. N. Pring, Professor A. O. Rankine, Dr. E. K. Rideal.

The Tudsbery Stress Indicator.—We have received from C. F. Casella and Co., Limited, 49 and 50, Parliament-street, S.W. 1, particulars of a stress indicator invented by Mr. H. T. Tudsbery, M. Inst. C.E., of the Ministry of Transport. The device consists simply of two McGruer hollow spars 4ft. long and ¾in. outside diameter, a dial indicator reading to 0.001in., and various clamps and clips of aluminium, brass or mild steel. As applied to, say, a steel tension bar of a bridge, the two spars are arranged collinearly with their outer ends clamped to the bar at points 8ft. apart. Their inner ends do not quite abut and are supported slidably in a bush which is clamped to the bar. On each side of this bush, but not quite touching it, lugs or sleeves are clamped to the spars. The lug on one spar carries the dial indicator and the lug on the other an arm, the end of which presses against the end of the indicator plunger. Thus when the bar is extended or compressed the total strain suffered by the 8ft. length is recorded on the dial indicator. The plunger of the indicator may be left quite free or may be subjected to frictional resistance, in which case the dial reading indicates, after the test is completed, the maximum strain experienced by the bar. It will be gathered that the instrument is strictly a strain indicator, and that to determine the stress it is essential to know the modulus of elasticity of the material under test. The instrument, we are informed, has recently been successfully used on the Queensferry Bridge over the river Dee.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	22/6
(1) Spanish	22/6
(1) N. African	22/6
N.E. COAST—	
Native	—
Foreign (c.i.f.)	22/- to 22/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	5 7 6	—
No. 1 Foundry	5 0 0	—
No. 3 Foundry	4 15 0	—
N.E. COAST—		
Hematite Mixed Nos.	4 13 0	4 13 0
No. 1	4 13 6	4 13 6
Cleveland—		
No. 1	4 16 6	4 16 6
Silicious Iron	4 16 6	4 16 6
No. 3 G.M.B.	4 12 6	4 12 6
No. 4 Foundry	4 7 6	4 7 6
No. 4 Forge	4 2 6 to 4 5 0	4 2 6 to 4 5 0
Mottled	4 1 0	4 1 0
White	4 1 0	4 1 0
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	13 0 0	—
North Staffs. Forge	3 12 6	—
,, ,, Foundry	4 4 0	—
(3) Northampton—		
Foundry No. 3	4 0 0	—
,, Forge	3 10 0	—
(3) Derbyshire—		
No. 3 Foundry	4 3 6 to 4 4 0	
Forge	3 17 6	—
(3) Lincolnshire—		
Basic	4 0 0	—
Foundry	4 2 6	—
Forge	4 0 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.		
Hematite Mixed Nos.	5 10 0	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 10 0	10 10 0
Best ,,	12 0 0	—
N.E. COAST—		
Crown Bars	10 10 0	—
Tees	10 0 0	—
LANCS.—		
Crown Bars	11 10 0	—
Second Quality Bars	10 5 0	—
Hoops	14 0 0	13 15 0
S. YORKS.—		
Crown Bars	12 0 0	—
Best ,,	12 10 0	—
Hoops	14 0 0	—
MIDLANDS—		
Crown Bars	10 7 6 to 10 15 0	
Marked Bars (Staffs.)	13 10 0	—
Nut and Bolt Bars	9 12 6 to 9 15 0	
Gas Tube Strip	10 10 0 to 10 15 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	12 0 0	—
Ship Plates ¼in. and up	9 0 0	—
Sections	8 15 0	—
Steel Sheets ⅛in. to ¼in.	10 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	17 10 0

STEEL (*continued*)

N.E. COAST—	Home. £ s. d.	Export. £ s. d.
Ship Plates	9 0 0 to 9 10 0	—
Angles	8 15 0 to 9 0 0	—
Boiler Plates	12 10 0	—
Joists	9 0 0	—
Heavy Rails	9 10 0	—
Fish-plates	14 10 0	—
Channels	13 10 0	—
Hard Billets	8 15 0	—
Soft Billets	8 0 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 10 0	—
Light ,,	9 10 0 to 10 0 0	
Billets	8 10 0	—
MANCHESTER—		
Bars (Round)	9 0 0 to 9 10 0	
,, (others)	9 10 0 to 10 0 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	12 5 0	12 0 0
Plates	9 0 0 to 10 0	
,, (Lancs. Boiler)	13 10 0	—
SHEFFIELD—		
Siemens Acid Billets	9 10 0	—
Bessemer Billets	12 10 0	—
Hard Basic	8 15 0	—
Soft ,,	7 5 0	—
Hoops	11 10 0	—
Soft Wire Rods	10 0 0	—
MIDLANDS—		
Small Rolled Bars	8 15 0	—
Billets and Sheet-bars	7 0 0	—
Gas Tube Strip	10 0 0 to 10 5 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets (f.o.b. L'pool)	17 0 0 to 17 10 0	
Angles	8 15 0	—
Joists	8 15 0 to 9 0 0	
Tees	10 0 0	—
Bridge and Tank Plates	9 0 0 to 9 10 0	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	19/6 to 19/9
Block Tin (cash)	174 12 6
,, (three months)	175 12 6
Copper (cash)	61 10 0
,, (three months)	62 7 6
Spanish Lead (cash)	25 5 0
,, (three months)	25 5 0
Spelter (cash)	38 7 6
,, (three months)	35 10 0
MANCHESTER—	
Copper, Best Selected Ingots	66 0 0
,, Electrolytic	70 0 0
,, Strong Sheets	96 0 0
,, Loco Tubes	0 1 1½
Brass Loco Tubes	0 0 11½
,, Condenser	0 1 2½
Lead, English	27 10 0
,, Foreign	26 7 6

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit
Tungsten Metal Powder	1/11 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£22	10/-
,, 6 p.c. to 8 p.c. ,,	£21 0 0	7/-
,, 8 p.c. to 10 p.c. ,,	£21 0 0	7/-
,, Specially Refined		
,, ,, Max. 2 p.c. carbon	£54 0 0	20/-
,, ,, 1 p.c. ,,	£64 0 0	22/6
,, ,, 0·75 p.c. carbon	£72 0 0	25/-
,, carbon free	1/7 per lb.	
Metallic Chromium	4/9 per lb.	
Ferro Manganese (per ton)	£15 for home.	
,, Silicon, 45 p.c. to 50 p.c.	£11 2 6 scale 5/- per unit	
,, ,, 75 p.c.	19 10 0 scale 6/- per unit	
,, Vanadium	17/- per lb.	
,, Molybdenum	9/6 per lb.	
,, Titanium (carbon free)	1/2 per lb.	
Nickel (per ton)	£160	
Cobalt	11/- per lb.	
Aluminium (per ton)	£82 to £100	

(British Official.)

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	24/- to 24/6
,, ,, Kil	25/- to 25,6
,, ,, Splint	26/- to 28/6
,, ,, Trebles	24/-
,, ,, Doubles	22/-
,, ,, Singles	18/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	24/-
,, ,, Splint	26/-
,, ,, Trebles	24/-
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	22,6 to 25,6
Screened Navigation	28/-
Trebles	25/-
Doubles	22/-
Singles	18,6
LOTHIANS—	
(f.o.b. Leith)—Best Steam	24/6
Secondary Steam	23/9
Trebles	24/6
Doubles	22/6
Singles	19/-

ENGLAND.

(8) N.W. COAST—	
Steams	29/6
Household	46/8 to 57/6
Coke	34/8
NORTHUMBERLAND—	
Best Steams	25/6 to 26/-
Second Steams	23/- to 24/-
Steam Smalls	12/6 to 14/6
Unscreened	20/6
Household	25/- to 28/-
DURHAM—	
Best Gas	24/- to 25/-
Second	22/- to 23/-
Household	25/- to 28/-
Foundry Coke	37/- to 40/-

SHEFFIELD—	INLAND.
Best Hand-picked Branch	32/6 to 34/6 —
Barnsley Best Silkstone	28/- to 30/- —
Derbyshire Best Brights	24/- to 26/- —
,, ,, House	21/6 to 22/6 —
,, ,, Large Nuts	19/6 to 22/6 —
,, ,, Small ,,	15/- to 16/6 —
Yorkshire Hards	20/- to 21/- —
Derbyshire ,,	19/- to 20/6 —
Rough Slacks	8/6 to 10/6 —
Nutty ,,	7/6 to 8/6 —
Smalls	3 - to 5/- —
Blast Furnace Coke (Inland and Export)	21/- to 30/-

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	28/- to 28 6
Second ,, ,,	27/- to 27/6
Best Dry Large	28/- to 29/-
Ordinary Dry Large	27/- to 28/-
Best Black Vein Large	26/- to 26/6
Western Valley ,,	26/- to 26/6
Best Eastern Valley Large	25/- to 25/6
Ordinary ,, ,,	22/6 to 24/6
Best Steam Smalls	16/- to 16/6
Ordinary ,,	12/- to 14/-
Washed Nuts	27/6 to 37/6
No. 3 Rhondda Large	28/- to 30/-
,, ,, Smalls	19/- to 20/-
No. 2 ,, Large	21/6 to 22/6
,, ,, Through	18/6 to 21/-
,, ,, Smalls	12/- to 14/-
Coke (export)	37/6 to 42/6
Patent Fuel	28/- to 30/-
Pitwood (ex ship)	33/6 to 34/6
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	40/- to 45/-
Seconds	35/- to 37/6
Red Vein	32/6 to 35/-
Machine-made Cobbles	57/6 to 62/6
Nuts	67/6 to 70/-
Beans	42/6 to 45/
Peas	22/- to 23/-
Breaker Duff	9/- to 9,6
Rubbly Culm	14/- to 14/6
Steam Coals:	
Large	25/- to 26/-
Seconds	23/- to 25/-
Smalls	10/- to 12/-
Cargo Through	17/- to 20/-

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England (7) Export Prices—F.O.B. Glasgow.

(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

French Engineering Notes.

(From our Correspondent in Paris.)

Industrial Progress.

WHILE the commercial community is agitating for a more liberal trade policy which will allow of business being done with foreign countries, manufacturers are, in many cases, claiming further protection, but whether such protection is necessary may appear doubtful in view of what may be inferred from the trade returns during the past few months. Those returns are particularly instructive, showing as they do that raw material is bulking more and more largely in the totals. Of the imports during the first ten months of the year raw material accounted for 36,361,917 tons out of a total of 41,860,494 tons, while the exports of raw material amounted to 15,763, 563 tons out of a total of 18,152,002 tons. There was an increase of close upon 10,000,000 tons in the raw material imports, and of nearly 5,000,000 tons in the exports. In manufactured goods the imports were 1,388,912 tons, and the exports 2,031,333 tons, there being an increase of 110,000 tons in the one case and of nearly 400,000 tons in the other. So far as values were concerned, the imports totalled 18,629 million francs, an augmentation of 900 million francs, while the exports, amounting to 16,156 million francs, showed a diminution of 279 million francs. Manufactured goods, although increasing in weight, decreased in value by 842 million francs for imports, and by 425 million francs for exports. The returns show that the French industry is working up considerable quantities of imported raw material, only a small part of which is exported in a manufactured state, and it may be concluded that the country has become, to a large extent, self-contained. This is taking place at a time when the manufacturing industry is only irregularly employed on account of the reluctance of capital to engage in industrial ventures, but the aggregate amount of work being done is large, and the fact that there is practically no unemployment proves that the situation is, on the whole, satisfactory. If the engineering trades are not fully active, it is due to the enormous increase in the productive facilities following upon the huge extensions of existing works and the creation of new ones during the war. Depending as they do largely upon reconstruction and public works, the contracts are not evenly distributed, and it is clear that when the new programmes are put in hand, there will be plenty of work for everyone, in which case it may be hoped that the activity will be reflected upon the industrial situation abroad.

Public Works.

The statements made by M. Le Trocquer in the Chamber of Deputies indicate that the Government is determined to do everything necessary to put in hand the vast programme of public works in the coming year. So far as some of the hydraulic schemes are concerned a good deal of progress has been made by the granting of concessions. The hydro-electric energy available for distribution increased from 1,500,000 horse-power in 1919 to 2,150,000 horse-power at the present time, while within ten years the amount of hydro-electric energy distributed will be 4,000,000 horse-power. As, however, the greater part of the programme can only be carried out with the aid of State funds and public loans, which are not available at the moment, the only hope of getting the programme executed within the allotted time lies in securing the participation of Germany on account of reparations. There is, moreover, not sufficient French labour, and French manufacturers could not supply all the machinery and material required. Therefore, as the programme aims at equipping the country with everything necessary to provide cheap motive power and cheap transport, French manufacturers have been induced to see that their interests lie in the German participation, the more so as they will themselves supply a large proportion of the machinery. It is by no means certain that Germany will fall in with the scheme so readily as it has done over the reconstruction of the devastated regions. The Germans affirm that they have no surplus labour.

Colonial Works.

The Governor-General of West Africa has returned to Dakar after arranging with the Government to provide, out of the loan of 167 million francs sanctioned by Parliament, the sum necessary for carrying out urgent works, such as the completion of the Thies-Kayes railway, which will put Dakar and Saint Louis into direct communication with the Niger Valley, the extension of the Ivory Coast Railway, and the construction of the line from Kotonou to Porto Novo. For the works to be carried out to make Dakar the biggest port in Africa it is proposed to spend 40 million francs. The Governor-General has presented another proposal for a loan of 55 million francs, which is to be employed for the preliminary works for the electrification of the Kayes Railway, and also for the construction of irrigation canals in the Niger Valley. The object of this irrigation is to create a vast cotton growing industry which will render France independent of foreign supplies.

Natural Gas.

The results obtained with natural gas at Vaux, in the Ain, and the discovery of marsh gas near Arcachon are encouraging research all along the zone where it appears likely that gas and probably petroleum may be found. There is no falling off in the pressure of gas at Vaux, which is maintained at more than 200 lb. per square inch, and for continuing boring operations near Arcachon a company has been formed for carrying the bores down to 600 m. and 700 m. if necessary. The bores now being made with rudimentary plants show the existence of gas and also traces of oil. The future, however, is still regarded as very uncertain, and although there has been no perceptible drop in the pressure at Vaux, there is some hesitation to put down costly mains for distribution until there are sound reasons for believing that the supplies are practically inexhaustible. The only installation being carried out at present is the laying down of mains from Vaux to Ambérieu.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

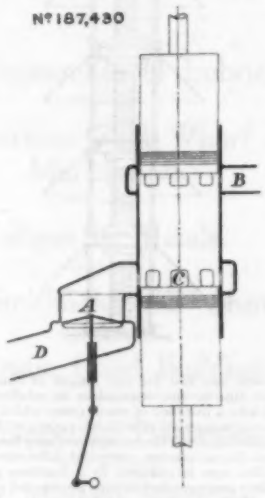
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

187,430. September 26th, 1921.—SCAVENGING OPPOSED-PISTON ENGINES, J. Romeyn, 162, Rue Emile Feron, Brussels.

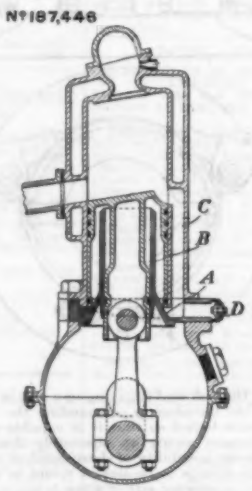
ACCORDING to this invention, the part of the exhaust pipe just close to the cylinder is shaped as an auxiliary cylinder A, in which a piston moves. During the exhaust period and the mere scavenging period the auxiliary piston lies in an enlargement of the pipe, so that the burnt gas and the little excess of scavenging air which is necessary for securing a thorough cleaning can pass freely from the main cylinder to the atmosphere through the auxiliary cylinder. After the scavenging period, *i.e.*, a little



past the dead centre, the auxiliary piston enters the auxiliary cylinder in a direction reverse to the flow of gas, stops the flow and compresses the burnt gas contained in the auxiliary cylinder and the passage connecting it with the main one, so that the whole quantity of fresh air entering the cylinder is used for the purpose of raising the pressure therein. The scavenging ports are shown at B and those for exhaust at C, while the main exhaust pipe is marked D. The auxiliary piston is operated by the crank and connecting-rod shown.—*October 26th*, 1922.

187,446. October 18th, 1921.—TWO-STROKE ENGINES, D. Scott, 56, Grant-street, Glasgow.

In this two-stroke engine the difficulties associated with crank case compression are overcome by compressing the charge between the underside of the piston and a partition reaching across the top of the crank case. This partition A has a cylindrical extension B, which acts as a guide for a corresponding

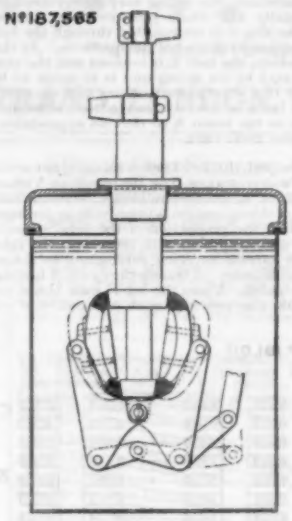


extension on the piston that receives the gudgeon pin. Piston rings are provided on this extension to make a tight joint with B. The compressed charge is transferred to the working cylinder by the passage C, while D is the air inlet valve.—*October 26th*, 1922.

SWITCHGEAR.

187,565. July 13th, 1921.—IMPROVEMENTS IN ELECTRIC SWITCHES, William Anselm Coates, of 36, Hartington-road, Chorlton-cum-Hardy, Lancaster; George Edward Gittins, of 36, Park-road, Stretford, Manchester; David Reginald Davies, of 85, Cyprus-street, Stretford, Manchester; and Metropolitan-Vickers Electrical Company, Limited, of 4, Central-buildings, Westminster.

The conductors on which the fixed contacts are supported are arranged concentrically, one conductor being tubular and enclosing within it the other conductor in the form of a rod. Two bridge pieces arranged vertically on each side of the fixed contacts are provided, the upper end of each bridge piece being adapted to connect with the fixed contact carried by the tubular support and the lower ends of the bridge pieces being adapted to connect with the fixed contact carried by the interior support which projects a suitable distance below the tubular support. The bridge pieces are mounted on bell-crank levers which are pivoted to and below the lower fixed contact, the free ends of

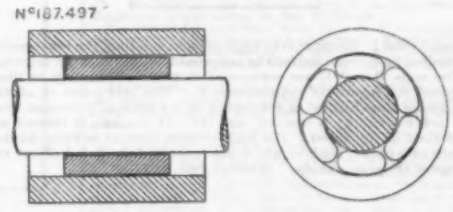


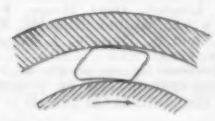
each pair of levers being connected by toggle links, one of which is extended and connected by a connecting-rod to the operating shaft of the switch.—*October 13th*, 1922.

TRANSMISSION OF POWER.

187,497. December 2nd, 1921.—FILM-LUBRICATED BEARINGS, F. J. Bostock and S. Bramley-Moore, Netherton, near Huddersfield.

This invention appears to be a development of the Michell type of bearing utilising the principle of lubrication discovered by Professor Osborne Reynolds, and the chief difference seems to lie in the fact that the pads supporting the shaft are not fixed in position, but merely float between the shaft and housing. One of the clauses in the claim reads as follows:—"A bearing comprising load-carrying members having disposed between



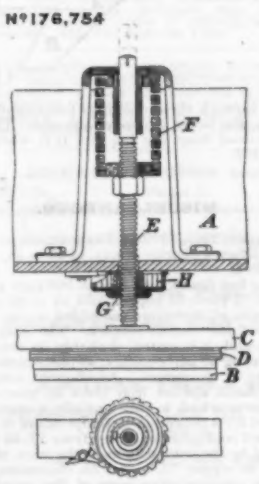


them a series of individually floating bearing elements of such smaller thickness than the distance between the opposed surfaces of the load-carrying members as will permit such elements, when in action, to move into positions in which each individual element contacts with both load-carrying members through the medium of tapered oil films in the manner set forth." The drawings, which show two alternative forms of pad, are self-explanatory.—*October 26th*, 1922.

TRANSFORMERS AND CONVERTERS.

176,754. November 3rd, 1921.—AN IMPROVED COMPRESSION DEVICE FOR ELECTRIC TRANSFORMER WINDINGS, Allmänna Svenska Elektriska Aktiebolaget, of Västeras, Sweden.

This invention relates to a spring device for following up and compensating the gradual shrinkage of transformer windings. The clamping beam for the iron core, which also serves as a

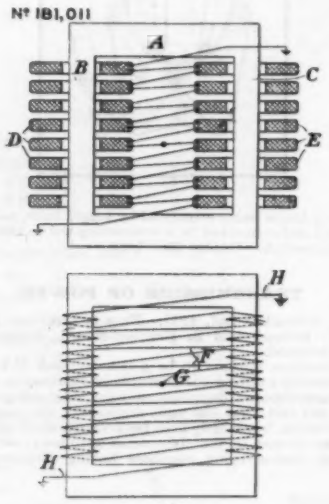


support for the winding compression device, is shown at A. On the top coil B of the winding is a wooden compression ring C, other insulating material also being provided at D. Bolts as shown, for example, at E are pressed downwards by springs as

shown at F. The bolt E is also provided with a nut G, which bears against the underside of the clamping beam A. This nut is actuated by a volute spring H enclosed in a casing, the rotation of which causes the spring to be wound up. As shown in the lower illustration, the casing may be revolved by a ratchet wheel. Normally the whole pressure from the compression spring F on the ring C is transmitted through the bolt E, whilst the nut G is entirely relieved of this pressure. As the shrinkage proceeds, however, the bolt E is lowered and the nut G is automatically rotated by its spring and is so made to bear against the beam A. If a short circuit occurs and the coil B is forced upwards, the force is directly transmitted through the bolt E and nut G on to the beam A so that no appreciable movement occurs.—*October 26th*, 1922.

181,011. June 3rd, 1921.—IMPROVEMENTS RELATING TO ELECTRICAL TRANSFORMERS, The Metropolitan-Vickers Electrical Company, of 4, Central-buildings, Westminster.

The object of this invention is to provide an arrangement of the windings so that the proportion of the total space occupied by the windings and insulators with respect to the space occupied by the active current carrying conductors in a transformer is reduced to a minimum. A transformer core A having two legs B and C is illustrated. Upon the leg B coils D are mounted and the leg C is likewise provided with a plurality of coils E. The

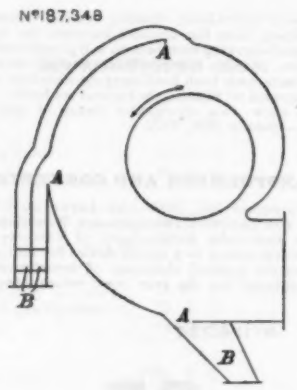


coils D and E constitute the high-tension winding, the low-tension winding being omitted for the purpose of simplifying the drawing. The coils D and E are connected in series alternately as illustrated by means of connections F. The mid-point G of the winding thus formed is connected to a source of potential from which the energy is derived, and the end portions H thereof are earthed as indicated. The high-tension current is thus divided into two paths, both of which are evenly distributed about the legs of the core member.—*October 26th*, 1922.

PUMPING AND BLOWING MACHINERY.

187,348. July 28th, 1921.—INDUCED DRAUGHT FANS, Babcock and Wilcox, Limited, Oriel House, Farringdon-street, London, E.C. 4; G. Walton, Holmlea, Woodberry-grove, Finchley, N.; and S. Thursby, 1, Stanley Park Villas, Sutton, Surrey.

The inventors propose to remove the dust from the gases handled by induced draught fans by providing sharp-edged orifices A A round the casing of the fan. It is claimed that the



dust will pass through these openings tangentially without the efficiency of the fan being seriously impaired. The dust can, of course, be removed from the hoppers B B when necessary.—*October 26th*, 1922.

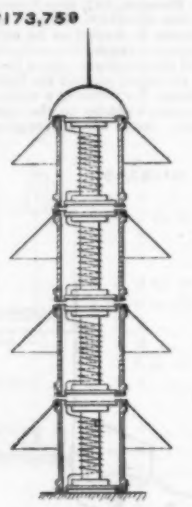
MISCELLANEOUS.

186,792. August 29th, 1921.—IMPROVEMENTS IN THERMO-COUPLES, *Edward Charles Marks, of 57 to 58, Lincoln's Inn-fields, W.C. 2.*

The inventor has found that if to a 100-part aggregate composed of 50 to 75 parts of copper and 50 to 25 parts of nickel from 5 to 30 parts of chromium are added, a very desirable product is obtained for thermo-couples. The maximum electromotive force would, it is stated, probably be obtained by using an alloy comprising 60 parts copper, 40 parts nickel and between 5 and 30 parts of chromium. An element composed of this product and placed against iron gives an electromotive force temperature curve which is substantially a straight line. The values obtained for a difference in temperature of 800 deg. Cent. between hot and cold junctions vary from 23.63 to 28.52 millivolts according to the composition of the wire, the latter value corresponding to copper 75, nickel 25, chromium 20. In order to increase the electromotive force of the couple and also to increase the resistance to oxidation of the other element, it is advisable to substitute for the iron an alloy composed of nickel and chromium of a composition substantially like that used in the nickel aluminum-nickel chromium couple now in use, namely, about nickel 100 and chromium 10. This not only increases the melting point and resistance to oxidation of the corresponding element, but increases the electromotive force per degree rise in temperature of the couple as a whole, so that it is large and approximately equal to the old iron-constantan couple, the melting point and resistance to oxidation of which were much inferior.—*October 21st*, 1922.

173,759. December 30th, 1921.—IMPROVEMENTS IN AND RELATING TO EARTHING CHOKING COILS OR VOLTAGE TRANSFORMERS FOR HIGH VOLTAGES, Emil Pfiffner, of Bahnhofstrasse 15, Mels, near St. Gallen, Switzerland.

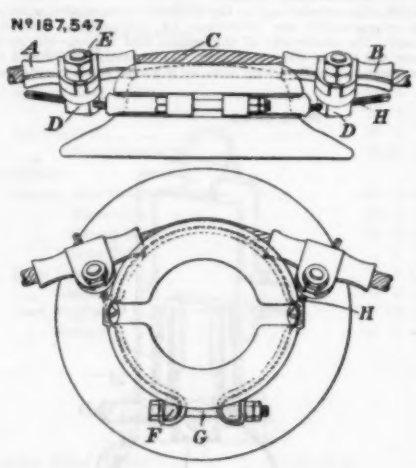
It is well known that for conducting away the so-called static charges in a network of electric mains the mains may be earthed at as many points as possible, either by high ohmic resistances or, in the case of alternating-current plants, by choking coils having a high self-induction. The high self-induction only takes up a small quantity of the wattless current at the frequency of the supply current, but the atmospheric charge can flow unhindered to earth through the winding, so that no high potential



difference to earth can last for any length of time. The principle involved in this invention consists in subdividing the iron core of the coil into a number of small cores which are insulated from earth and are connected at suitable points with the winding, which is also subdivided. The connections may be made through a condenser and the maximum potential difference between the windings and the core is reduced to a fraction of the supply voltage. Another arrangement is also illustrated and described.—*October 26th*, 1922.

187,547. March 31st, 1922.—IMPROVED MEANS FOR ATTACHING CONDUCTORS TO ELECTRICAL INSULATORS, George Victor Twiss, of 39, Victoria-street, London, S.W. 1.

In the form of the invention illustrated the clamp comprises two bell-mouthed clamping pieces A B, which can be clamped on to the conductor C by means of bolts D and nuts E. Surrounding the neck of the insulator there is provided a copper strip with the ends bent round wedge-shaped metal pieces F and drawn tight on to the neck of the insulator by a bolt G. The clamp is attached to the metal strip by a rod H screwing into the nut D



on the head of the bolt and engaging in a slot in the cup-shaped projection on the metal strip surrounding the insulator. The end of this rod is balled so that it is capable of a practically universal movement giving an absolutely flexible connection which obviates any possibility of sharp bending of the conductor and enables the clamps to be slewed round so as to be readily attached to the conductor either when lying in the top groove of the insulator for straight-line work, or in the side groove for bends in the line.—*October 26th*, 1922.

CONTRACTS.—John I. Thornycroft and Co., Limited, are constructing six auxiliary motor cruisers, each 67ft. in length to be equipped with machinery developing 180 brake horse-power; two river motor launches of 30ft. and 35ft. in length respectively, each to be equipped with one of the firm's new D B/2 marine engines of 9 brake horse-power; a cabin cruiser of 48ft., to be equipped with a type M/4 30 brake horse-power motor with reducing reversing gear; a fast cabin launch 40ft. in length, in which are to be installed two type Z/6 engines each developing 70 brake horse-power; an auxiliary cruiser of the "Gamecock" type, which will be equipped with a type M/2 15 brake horse-power engine; a 25ft. hydroplane, to be equipped with a type A B/4 30 brake horse-power engine; the two 55ft. coastal motor boats; a 66ft. auxiliary cruiser, to be fitted with a type C/6 70 brake horse-power engine, with reducing reversing gear; and a 65ft. passenger motor launch, to the order of the Dee Steamboat Company, to be equipped with two Thornycroft type M/2 engines, with reducing reversing gears. All the boats mentioned are for foreign service, with the exception of the last-named.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

THE JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, Westminster, S.W. 1. Lecturette, "Machines Used in Magnetic Separation," by Mr. H. G. Brown. Slides. 7.30 p.m.

THE INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W. 1. Thomas Hawksley Lecture, "Some Recent Researches on Lubrication," by Dr. T. E. Stanton. 6 p.m.

THE INSTITUTION OF LOCOMOTIVE ENGINEERS: MANCHESTER CENTRE.—College of Technology, Manchester. Discussion on "Some Details of Locomotive Practice," opened by Mr. J. W. Smith. 7 p.m.

NORTHAMPTON POLYTECHNIC INSTITUTE.—St. John-street, Clerkenwell, E.C. 1. Annual prize distribution by Dr. S. Z. de Ferranti. 7.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Literary and Philosophical Society, Newcastle-upon-Tyne. "Some Factors Affecting the Utilisation of Heavy Oils in Internal Combustion Engines," by Mr. H. Moore. 7.30 p.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE.—Royal Technical College, George-street, Glasgow. Paper, "Consideration in the Use of Electricity in Steel Works," by Mr. W. MacFarlane. 7 p.m.

SATURDAY, DECEMBER 2ND.

MANCHESTER ASSOCIATION OF ENGINEERS.—Midland Hotel, Manchester. Smoking concert. 7 p.m.

INSTITUTION OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—College of Technology, Sackville-street, Manchester. Address, "My Visit to American Foundries and Impressions," by Mr. Oliver Stubbs. 4 p.m.

MONDAY, DECEMBER 4TH.

THE INSTITUTION OF CIVIL ENGINEERS: NEWCASTLE-UPON-TYNE ASSOCIATION.—Neville Hall, Newcastle-upon-Tyne. Paper, "Some Aqueducts and their Construction," by Mr. J. E. Parker. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. General meeting. 5 p.m.

THE SOCIETY OF ENGINEERS.—The Geological Society, Burlington House, W. 1. Paper, "Wave Power Transmission," by Mr. W. Dinwoodie. 5.30 p.m.

TUESDAY, DECEMBER 5TH.

INSTITUTE OF MARINE ENGINEERS, 85-88, The Minories, Tower Hill, E. 1. "Marine Diesel Engines," by Mr. A. J. Brown. 6.30 p.m.

THE INSTITUTION OF CIVIL ENGINEERS.—Great George-street, S.W. 1. Paper, "Strengthening of the Floor, &c., of the Forth Bridge," by Mr. W. A. Fraser. 6 p.m.

THE INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—Chamber of Commerce, New-street, Birmingham. Paper, "Some Notes on Casting 70: 30 Brass," by Mr. R. J. Redding. 7 p.m.

WEDNESDAY, DECEMBER 6TH.

NORTHAMPTON ENGINEERING COLLEGE ENGINEERING ASSOCIATION.—St. John-street, Clerkenwell, E.C. 1. Paper, "Oxy-acetylene Welding," by Captain D. Richardson. 5.30 p.m.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, W.C. 2. Wireless Section meeting. "A Direct-reading Thermionic Voltmeter and its Applications," by Mr. E. B. Moullin. 6 p.m.

INSTITUTION OF RAILWAY SIGNAL ENGINEERS.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C. 2. Paper, "Intermediate Block Signalling," by Mr. C. Carslake. 3 p.m.

THE INSTITUTION OF AUTOMOBILE ENGINEERS.—The Institution of Mechanical Engineers, Storey's-gate, S.W. 1. Informal meeting. 7.30 p.m.

INSTITUTION OF BRITISH FOUNDRYMEN: BURNLEY SECTION.—Municipal College, Ormerod-road, Burnley. "The Camber of Castings," by Mr. R. McLaren. 7.15 p.m.

THURSDAY, DECEMBER 7TH.

INSTITUTION OF MECHANICAL ENGINEERS: NORTH-WESTERN BRANCH.—Memorial Hall, Manchester. Thomas Hawksley Lecture, by Dr. T. E. Stanton. 7 p.m.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, W.C. 2. "The Possibilities of Transmission by Underground Cables at 100,000/150,000 Volts," by Mr. A. M. Taylor. 6 p.m.

LIVERPOOL ENGINEERING SOCIETY: STUDENTS' SECTION.—Royal Institution, Colquitt-street, Liverpool. Paper, "Water Examination for Public Services," by Mr. D. Lloyd. 7.30 p.m.

FRIDAY, DECEMBER 8TH.

THE INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—38, Victoria-street, S.W. 1. "Centrifugal Pumps as Applied to Heating Installations," by Professor A. H. Barker. 7 p.m.

THE JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Lecturette, "The Michell Thrust Bearing" (slides), by Mr. J. Ward. 7.30 p.m.

THE INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, S.W. 1. Informal meeting. Lecture, "The Manufacture of Solid-drawn Steel Tubes and their Jointing" (slides), by Captain J. A. Richards. 7 p.m.

THE INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—Mappin Hall, St. George's-square, Sheffield. Paper, "Cobalt," by Mr. W. R. Barclay. 7.30 p.m.

TUESDAY, DECEMBER 12TH.

INSTITUTE OF INDUSTRIAL ADMINISTRATION.—London School of Economics, Houghton-street, Aldwych, W.C. 2. Lecture, "Standardisation of Repairs in Relation to Industrial Economy," by Mr. R. Twelvetrees. 8 p.m.

WEDNESDAY, DECEMBER 13TH.

THE INSTITUTION OF AUTOMOBILE ENGINEERS.—The Institution of Mechanical Engineers, Storey's-gate, S.W. 1. Paper. "Improvements in Efficiency of Roadless Vehicles," by Lieut.-Colonel P. H. Johnson. 7.45 p.m.